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EXTRAARTICULAR OSTEOSYNTHESIS FOR RECENT FRACTURES OF THE NECK OF THE FEMUR: A DISCUSSION OF THE TECHNIQUE AND A REPORT OF PERSONAL EXPERIENCES.

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IN the following observations no attempt has been made to include the whole subject of fractures of the neck of the femur. They are based merely on experiences with a particular method of treatment. The method of treatment has been considered in detail, because, although the general plan of the method is simple, a successful application of it demands attention to intricacies of technique. This method has brought many mistakes which experience is gradually eliminating. I had not intended describing the method in detail, but have been encouraged to do so by experienced surgeons and orthopædists, although for these much of the descriptive minutiæ will be very obvious indeed. There is always the likelihood of less experienced surgeons trying this method. It is for these that this detail is intended. Throughout, I have endeavoured to acknowledge the valuable work of others.

When Kocher published, in 1896, a series of five cases of subcapital or intracapsular fractures of the femoral neck, which he had treated by primary removal of the head, we saw the surgeon, armed with antisepsis and asepsis, launching a determined operative attack on a very troublesome problem, although this had been suggested by Senftleben in 1858 and carried out by Schede in 1878. Kellogg Speed, writing in 1935, calls this "the unsolved fracture . . . because although the results obtained today show improvement, they are not at all comparable to those of other fractures". This is true because in certain cases the fragments will fail to unite by bony union despite the most modern,

skilled treatment. With the advent of the Smith-Petersen trilaminar nail we are very close to a solution of the question. It is undoubtedly the most satisfactory method that we have of treating this difficult fracture. It has revolutionized the pitiable outlook for old people who have had the misfortune to sustain this crippling injury. Notwithstanding the big improvement in good results which has followed the general adoption of the Whitman method in the last twenty years, the use of the nail, although not entirely safe or certain, is our safest and most certain method of insuring fixation of the fragments. Unfortunately, until the secrets of the nature of life itself are revealed, little more than mechanical means can be hoped for in any new method or improvement devised by mortals. In the meantime the experiences of various surgeons should be freely given in order to promote further advances. The publication of all accidents, difficulties and complications is far more valuable in assessing the worth of any particular treatment than are the brilliant successes.

Lelio Zeno, of the Argentine Republic, has recently published a comprehensive account of these fractures considered from all aspects. In a recent letter he states an idealistic belief which all surgeons will approve of when he writes:

> Our enthusiasms and convictions in any surgical procedure should be exposed without reserve, because no matter how perfect it seems to us, next day somebody may introduce substantial modifications reducing to a second stage what we thought was a perfect thing to do.

Having this in mind, I publish the following record of experiences in a small number of cases, thirty-six in all, operated upon by this method.

Three types of fracture of the neck of the femur are recognized: (i) Medial, subcapital (decapitation fractures of the French) or transcervical, also called intracapsular; (ii) lateral or trochanteric fractures, also called extracapsular fractures, because most of them are mainly distal to the anterior attachment of the capsule to the intertrochanteric line; (iii) fracture separation of the femoral head epiphysis.

It is well known that in the last two types of fracture non-union is a rarity, because the blood supply of the proximal fragment is assured. On the other hand, non-union is the rule in the first type, unless, and sometimes despite the fact that, reduction is accurate and immobilization is complete and uninterrupted. Therefore if the injured member were merely placed between sand bags, bony union would be a miracle indeed.

If the affected extremity is suspended in a splint or slung by the Hamilton Russell system, treatment which otherwise is excellent, as for example in trochanteric or femoral shaft fractures, bony union cannot be expected except very rarely. By this treatment the hip joint is not immobilized and rotation between the fractured surfaces is continually occurring. Therefore on theoretical grounds bony union could never occur; but actually bony union has occurred with this method in rare instances.

MacAusland, MacAusland and Dee report two cases successfully treated by traction, and show one X ray picture of bony union two years later. Böhler states that he has had occasional successes. Notwithstanding this, except as a temporary measure, treatment by traction is to be condemned if the surgeon is attempting with any seriousness to obtain bony union. Unfortunately this almost useless method appears to be the most popular and frequently adopted.

To be condemned, even more, is the early ambulation of the patient in a walking caliper, devised by Thomas for knee injuries, and not of course for hip diseases, unless of course more deliberate treatment is contraindicated. Presumably advocates of this treatment are deliberately aiming at a "firm fibrous union", a phrase covering a multitude of sins. But such advice misleads the inexperienced who do not appreciate that ligaments, whether anatomical or of new formation by the organization of fibrous tissue, cannot bear weight without stretching. Thus the pathological dislocation of the hip following weight bearing, when anterior poliomyelitis has resulted in paralysis of the hip musculature, is a well known example. In old fractures of the neck of the femur with fibrous union, the distal fragment characteristically ascends on the *dorsum ilii*; the Y-shaped ligament stretches, especially the upper band, and the *obturator internus* and gemelli muscles in particular are hypertrophied and stretched (Figure XXIV). As for the fibrous union between the broken head and neck, little can be expected therefrom in the way of a bond of strength. It is not uncommon to read that fair to good function occasionally follows such fibrous union, consequently the inexperienced may feel justified in selecting this method because they can carry it out themselves. Then the patient is not referred for more expert treatment which aims at bony union. One would have personally to experience the disability fairly and fully to judge the inconvenience. But in my own observations it has been clear that when a patient who has a painful hip which, owing to an ununited fracture, will allow of only a few hundred yards' walk, then the patient's cheerful assertion that he is fairly comfortable and equally satisfied (statements often made to please the surgeon, but behind his back the patient may complain, as well he may) cannot be accepted as evidence of "fair to good function". Closer inquiry has elicited that whereas the patient could walk any reasonable distance before the injury, now a few hundred yards is the limit of his walking capacity. It is almost the universal rule that non-union is followed by a severe disability. The only assurance of a stable and painless hip joint is that bony union must be present. That is the object of treatment. In those cases in which the patients have been treated in a large plaster cast for some months, but with failure of bony union, the same displacement of the distal fragment on to the *dorsum ilii* is not always seen. Presumably a shorter and firmer fibrous union has occurred. Nevertheless considerable disability results.

The conservative method of handling these fractures, that is the "Whitman abduction treatment", if carried out under X ray control and followed by the application of a plaster cast from the

toes to the nipple line, is also both a time-consuming operation and one of no little magnitude. It requires an experience in the application of the plaster spica which is not always within the capabilities of the medical attendant. Whitman, in a personal communication, states that this method should not be judged by its success or failure when the reduction and application of the cast have been performed by those who are unaccustomed to it, especially as the rival operative methods are presumably carried out by experts. Uncomfortable casts must be removed too early; thereby non-union results. If much padding is used the hip is not properly immobilized and rotation between the surfaces of the fragments can occur, resulting in a shearing movement which tears the newly formed capillary loops in the early granulation tissue of the callus scaffolding. That these large casts are uncomfortable for elderly people has always been recognized. A number of patients would be unsuitable for treatment for this reason alone, even though such patients need not be refused operation by the Smith-Petersen nail, after which no plaster cast is required. A noted authority on the Whitman method, Löfberg, excluded 20% of his material as unsuitable for treatment; of 168 patients treated in the big plaster cast 7% died. Therefore this method is not to be lightly regarded as a very conservative measure just because it is a non-operative procedure. A further innovation over all other internal or external splints is the control of all rotatory movement obtained by the Smith-Petersen nail, and rotatory movement more than any other movement causes non-union of the fragments. Providing the reduction has been satisfactory, the immobilization which may not be perfect in a cast, will nevertheless be sufficient if the cast has remained unsheathing the patient for a long enough period. Unfortunately the removal of the cast after three months has often resulted in the fragments separating again at the fracture site. The method has then been blamed. But had the cast remained for six to twelve months union might have ensued. Old people can hardly be expected to spend six to twelve months of their few remaining years in such an uncomfortable apparatus. Therefore an operative measure is preferable if it offers a more certain promise of union, in a minimum of time, with an absence of splints and practically free mobility of the limb before union is sound. The modern scientific treatment of this fracture with the Smith-Petersen nail best fulfils the above requirements.

Extraarticular or Intraarticular Osteosynthesis with the Three-Flanged Nail?

In the last three years I have been concerned directly or indirectly in the treatment of over forty medial fractures of the neck of the femur. Thirty-six of these were dealt with by the subcutaneous introduction of the Smith-Petersen nail through a small extraarticular incision and four by arthrotomy and exposure of the fracture site and introduction of the nail under direct vision. Two of the latter operations were very easily performed, the duration of each being twenty-five and thirty-five minutes. No bleeding vessels of importance were noticed. Yet both wounds became infected owing to necrosis of the skin flap (hence warm packs have been recommended to avoid this). A third case was difficult, because of well developed muscles, especially the reflected head of *rectus femoris*. Bleeding was free. The wound became infected and the patient died after six days. He had become extremely shocked on the operating table. Zeno also records a collapse during the operation. The absence of shock or constitutional symptoms has often been noted as a special feature of the arthrotomy as reported by Smith-Petersen and others. Nevertheless the very nature of the operation presumes on theoretical grounds that shock is a factor against which sooner or later the surgeon must contend. Consequently for many years a group of French surgeons have favoured extraarticular osteosynthesis because they feared decubitus, sepsis, embolism, heart failure and hypostatic pneumonia. Lambotte, however, has expressed himself otherwise when presumably referring to this:

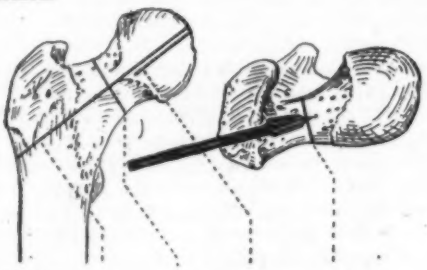
"... *dans l'emploi systématique de demi-moyens prétendus peu dangéreux (vissages du col à l'aveuglette); je considère cela comme de la demi-chirurgie.*"

In a fourth case also non-union resulted. Furthermore a number of failures of union after arthrotomy have been recorded, and this non-union and death of the head may be attributable to the extensive nature of the operation. In exposing the joint, muscles and blood-vessels are divided. The capsule and synovial membrane are widely incised. Whether similar failures will be so liable to occur with extra-articular osteosynthesis remains to be seen.

It became very evident that sepsis was the factor to be feared. These patients, being old, frail, often unhealthy, are being subjected to a large division of skin and muscles with arthrotomy as well. Some form of hæmatoma is almost inevitable. The skin is often unhealthy, easily bruised and burnt by the skin iodization. The nursing is difficult, and post-operative urinary incontinence is often associated with a preexisting chronic cystitis, so common in female patients, who form by far the greater portion of those afflicted with this fracture. The large wound is thus very subject to sources of infection developing in it. Pulmonary embolism has been often reported in the German literature. Böhler has become an ardent advocate of extraarticular osteosynthesis as a result of the following experiences with intraarticular osteosynthesis, according to the original technique of Smith-Petersen. From 1930 to 1932 he performed twenty-two operations for intraarticular osteosynthesis. Of the twenty-two patients five died a few days after operation. In two other cases pseudarthrosis developed (almost inevitable because of the atrophic bone of the neck in one and the presence of tabes in the other). Of the remaining fifteen patients five presented post-operative infection of the wound and skin necrosis; ten healed by first intention. In five cases it was necessary to remove the nail, in some instances for mechanical reasons, in others for rarefaction of the bone and intolerance of the nail. Of the fifteen patients thirteen showed bony union, one certain and another probable pseudarthrosis.

According to a recent statement, since 1933 he has performed the extraarticular osteosynthesis according to Sven Johansson twenty times and the intraarticular operation only once, and then because he failed to reduce the deformity by closed methods. He has had no deaths and no infection of the wound. He recently stated:

I believe that the treatment of fracture of the neck of the femur by extraarticular nailing . . . should be adopted as the proper method.



Maximum	11.1	4.7	4.0	3·3
Minimum	8.0	3.0	2.8	2.5
Average	10.0	3.6	3.5	2.8
Variant	3.0	1.7	2.2	0.8

Figure I.

Diagram from Sterling Bunnell showing the measurements, in centimetres, which were determined from fifty femora. The length of the upper end of the femur from the subtrochanteric fossa to the fovea or apex of the head was ten centimetres (four inches), but varied from eleven centimetres (four and a half inches) to eight centimetres (three and a quarter inches). In the presence of a fracture, however, the length of the neck will be usually shorter because the bone is buckled and compressed by the injury, and later by the impacting operation, especially if the bone is soft or the fracture is of the comminuted type. Note the narrow diameter of the neck in the lateral view, being just over 2·5 centimetres (one inch). In the frontal view it averages nearly 3·6 centimetres (one and a half inches). Consequently it is easier to penetrate the front or back surfaces of the neck with an ill-directed nail than it is to go through the upper or lower surfaces.

It was because of the danger of sepsis in the first place, and in the second place because conservative measures, if as effective as procedures of greater magnitude, should prevail above all things in orthopædic surgery, that I abandoned nailing through a large arthrotomy wound. It is only fair to point out that Smith-Petersen in fifty cases, which are to be published, had only three cases of septic infection of the wound. Lelio Zeno in twenty cases had no trouble. The former has had bony consolidation in 70% of the cases. In Zeno's series there were twenty cases. Among twelve recent medial fractures operated on there were eight perfect results; two others united, but osteoarthritis supervened; one was a failure because the nail was placed too high in the neck, and the remaining patient developed angulation at the fracture site two years later owing to some unknown idiopathology. Four patients were operated upon for pseudarthrosis, two with satisfactory results. Four other patients had lateral fractures in the trochanteric region, two had perfect results after the operation, one died, and the remaining patient developed adduction deformity (comminuted case).

Since August, 1933, of a consecutive series of forty-seven recent subcapital fractures which I have seen, thirty-six have been nailed by the extra-articular method. Of the patients for whom nailing was not used, one was too old and feeble (aged ninety-four), four patients died within a short time and for them traction alone had been used, and six patients had strongly impacted fractures (*coxa valga* type as in Figure XXVII). The remaining thirty-six patients were treated by the method of extra-articular osteosynthesis which I have already described eighteen months ago and which I have been using for over two years. Therefore there has been no careful selection of cases, and the method can be regarded as exceedingly safe. The average period which has elapsed since the operation is about seven months. A summary of the results is set out at the end of this article.

Practically an entire absence of pain with excellent stability and ability to walk well is present in all the successful cases. Some patients walk better than others, but none are crippled or anything approaching that condition. There are no stiff knees. That mobility would be less affected by this method than by the intraarticular introduction of the nail, which requires division of muscles, ligaments, capsule and synovial membrane, is only to be expected. The range of movement has varied from "perfectly normal" to "some limitation". Infection of the

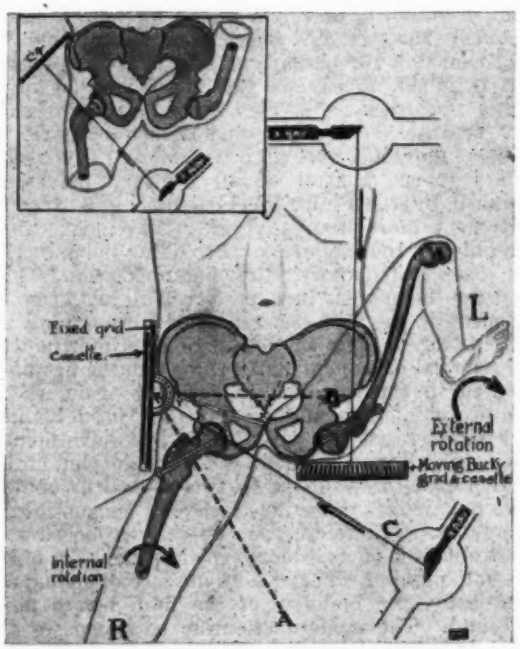


Figure II.

The larger drawing shows two methods of making lateral X ray examinations of the proximal end of the femur. On the right limb the picture is taken by directing the central ray from the target along a line which subdivides the angle formed between the long axis of the casette and that of the neck. The other limb is flexed so that the ray from the target is not obstructed. On the orthopædic table, however, this is not quite practicable. Therefore a shock-proof X ray tube is placed in the perineum very close against the *symphysis pubis* (Figure XXI). In the latter case the pictures are not so true as regards distortion, but the relative anatomical bony structures remain the same. In either case very slight errors in directing the central ray result in "missing the head" or in great distortion. The inset drawing shows the casette lying parallel with the long axis of the head and neck as recommended by Johansson, but similar distortion can occur. On the left limb is shown the best method, but in the case of fractures it can be utilized only when the fragments have been fixed by the nail. It is therefore used as soon as the nail has been inserted because far better pictures are obtained with this method than by the method shown in Figure XXI. The thigh is flexed at right angles to the position used for making the ordinary frontal picture (lithotomy position). Therefore it must be a true lateral view because it is a view exactly at right angles to the frontal view. A great advantage is that the view is obtained on the Potter-Bucky diaphragm.

wound has not occurred, although in one case a small shallow sinus persisted for about two months, but healed up; bony union has occurred in this case and the patient walks well (Figures XXXIV, XXXV and L). It is too early yet to report on the late results (that is after two years), especially in regard to traumatic osteoarthritis.

Dr. Melvin S. Henderson, Chief of the Orthopædic Section at the Mayo Clinic, told me that he considers a method of introducing the nail without arthrotomy to be obviously superior. This opinion, coming from a surgeon of such wide experience, is all the more weighty in its authority because at the Mayo Clinic, after 113 operations which were performed mainly for ununited fracture of the femoral neck and in which arthrotomy was performed, only 4·4% of patients developed infection of the wound. He writes:

> I am positive—or as near as one can be in our work—that your technique of using the wire and cannulated nail is fundamentally correct. We must keep at it and demonstrate its value. Merely because it is a bit difficult at times must not deter us.

He later writes:

> I am still working with the metal nail, but I am not quite convinced as to the best way to perform these operations.

He now favours exposure of the fracture.

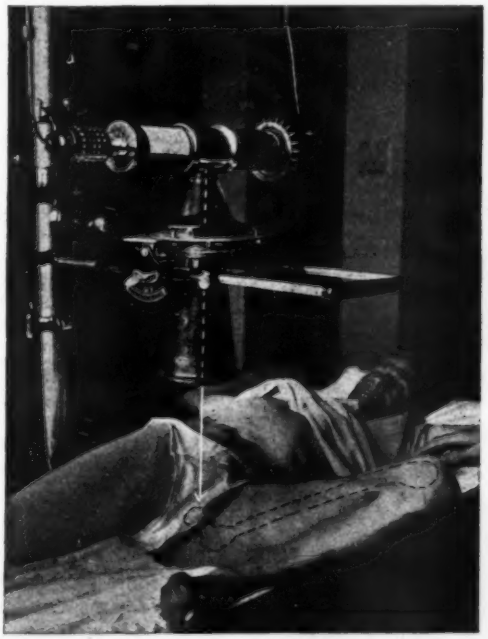


FIGURE III.
First method of making a lateral examination of the neck and head of the femur with the limb in the lithotomy position. The thigh is flexed at right angles, rotated outwards, and abducted as far as possible. Pictures are taken through the Bucky grid. This method is used as soon as the fragments have been nailed, when the patient has been removed from the orthopædic operating table to the trolly. A Lysholm grid is generally used.

For those who still believe that arthrotomy has a place in the treatment, the operation used by Dr. C. Littlejohn, orthopædic surgeon at the Melbourne Hospital, requires a less extensive exposure of the hip joint than the Smith-Petersen operation (thereby avoiding the danger of skin necrosis), although at the same time it is a major procedure. An incision about 20 to 25 centimetres (8 to 10 inches) long is made over the lateral aspect of the proximal end of the femur as proposed by M. O. Henry. The great trochanter is sawn through and the fracture is exposed by a longitudinal arthrotomy incision. After reduction with the aid of a blunt hook, a nail is driven into the femoral neck and head. It is difficult to fix the trochanter and its muscles back again firmly

FIGURE IV.
Second method of making the lateral X ray examination. This is used when the thigh cannot be flexed to a right angle or before the fragments have been nailed. The Bucky table is used.

on to the femur. A small nail is easy to use for this purpose, but not very effective. Two loops of wire passed through drill holes would give firm fixation, thereby allowing early movements, but this prolongs the operation and is quite a troublesome procedure.

Since 1907 Delbet has been the high priest in France of extraarticular osteosynthesis for fractures of the femoral neck. He prescribed a screw, at first of wood, latterly one of rustless steel, also a fibular transplant; but now, I believe, he uses the original model of the Smith-Petersen nail. The nail is held in a grooved guide or aiming apparatus, which is adjusted by X ray control so that the nail can slide along it when hammered into the neck and head. This aiming apparatus originally was used for guiding the drill hole and screw or bone-peg into the femoral head. This method has been, on the whole, superseded by the canaliculized three-flanged nail which can be guided along a 1·5 millimetre (one-sixteenth inch) stiff straight steel wire previously drilled into the head and neck of the femur (see below). Henshen, of Basle, has used this wire guide for a screw in his clinic since 1930, and in 1931, before the canaliculized Smith-Petersen nail was suggested or used, Richard published an account of the canalized screw operation. He used the Kirschner wire as a guide for a screw

which had a hole down the centre of it. Of course the screw-driver was similarly drilled in its length by a hole of corresponding calibre. His custom is to drill in several wires and to select the best directed one, under X ray control. The screw method has the inherent objection that rotation between the fragments is not prevented unless two screws are used, as advocated by Masmonteil. Such guiding methods as putting the finger behind or in front of the femoral neck or the placing of wires on the skin over the hip joint, followed by the taking of X ray pictures, are too uncertain, and have been generally abandoned. Whilst such methods are very commendable, if good, on account of their simplicity, it is for this very reason that they should not be put forward by surgeons unless they have thoroughly proved them. Otherwise they tempt the inexperienced to essay what they anticipate will be an easy procedure, but one which is really a very unsatisfactory one over a series of cases. Any closed method is unsound and to be condemned which does not consider frontal and lateral X ray control pictures after attempts have been made at reduction of the deformity.

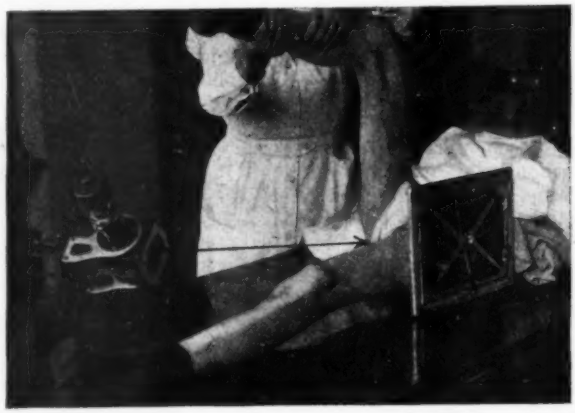


Figure V.

Third method of making the lateral X ray examination of the hip. The central ray from the target should subdivide the angle formed between the long axis of the neck and the casette, which is held close to the skin. The upper margin of the casette should reach beyond the upper edge of the iliac crest.

Westcott (Virginia) described a simple method of introducing a nail. Having by X ray examination determined the angle of torsion and also the neck-shaft angle, he rotated the femur internally through an angle equal to the torsion angle. Thereby the neck of the femur was considered to be horizontal with the table. Then a protractor, set at the previously determined neck-shaft angle, was placed against the lateral aspect of the shaft of the femur, which was exposed by a moderately small incision. The nail was then directed accordingly. He has reported eighteen cases. No lateral X ray pictures have been published. Quite independently J. W. O'Meara (America) has devised a similar method. He has published the results and frontal X ray pictures in twelve cases. The nail has been perfectly placed in the frontal view; no lateral views were published. The success obtained by these surgeons is no doubt due to an unerring sense of direction with which few have been talented. In other hands this method has certain obvious loopholes through which can be introduced inaccuracies. Krauss (Germany) has used a somewhat similar protractor for guiding a wire into the bone, which later acts as a guide for the nail (see below). Lelio Zeno placed a Steinmann's pin (fine) behind the neck. Frontal and lateral X ray pictures, with the pin in position, if showing good reduction of the fracture and correct placing of the pin (frontal X ray picture) were followed by driving the nail in the direction indicated by the pin. Nevertheless Zeno is a strong advocate of arthrotomy.

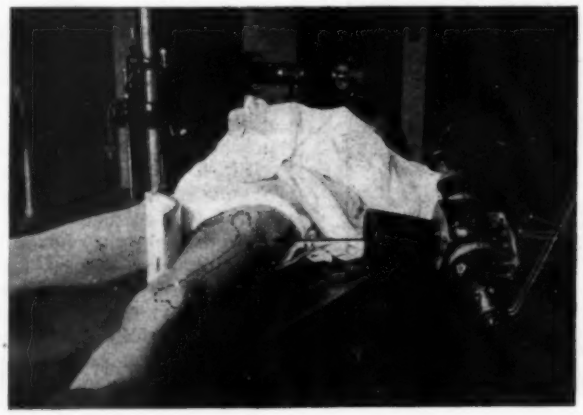


Figure VI.

Fourth method, which has been in use for a number of years, for the lateral examination of the hip joint, with a curved casette in the perineum.

The construction of a three-flanged nail, having a fine hole along the whole length at the junction of the three blades, was an obvious idea which was discovered by several authors independently. Jerusalem (Vienna) used a drilled head only, because an engineer told him the whole nail could not be drilled, but Johansson (Gothenburg), Niklas (Germany) and myself, unknown to one another, besides no doubt others, had the whole length of the nail drilled. Dr. George Clemons, of Launceston, also thought of this method. B. H. Burns (London) reported fifteen cases in which he had drilled a number of wires into the femoral neck. Thereafter he chose the best one to act as a guide for a canaliculized nail. Johansson gave the first full account of his experiences of seven cases in 1932, and has recently published a magnificent monograph with a report of fifty cases. In fifty operated cases only four were lateral fractures. He reported osseous healing in forty-two cases, five deaths, and three patients still under observation. Johansson's drill is held in an elaborate and very beautifully designed aiming apparatus or guide.

Three small lead markers having been placed parallel with and just distal to the middle of Poupart's ligament, a frontal X ray picture is taken. One of the lead marks is approximately over the region of the central point or apex (fovea) of the head of the femur. Any slight adjustment being made, the "sight" on the drill guide is directed towards this point. A mistake can easily be introduced because the skin markers are separated by two inches or more

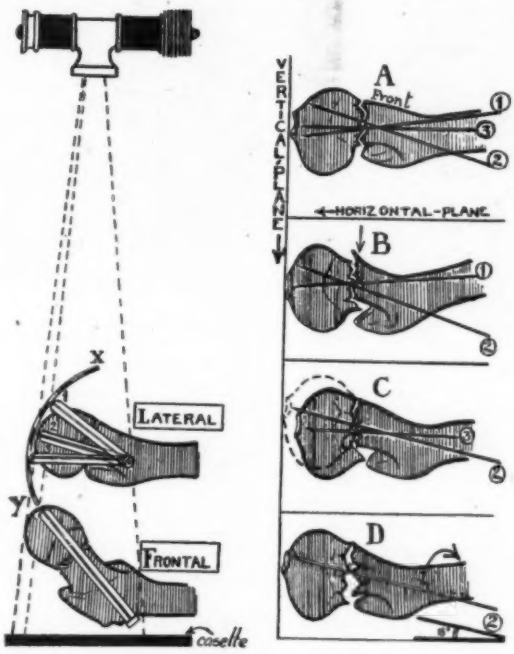


FIGURE VII.

The left composite diagram shows how a nail can project through the front or back aspects of the neck or head and yet appear in the frontal view to be perfectly placed. On the right are diagrams of the lateral aspect of the upper end of the femur showing some problems in drilling a guide wire which will be so placed in the bone that the nail will be surrounded by bone on all sides later:

In Figure A there is ideal reduction with no destruction of bone from buckling on the posterior aspect of the neck as in Figures C and D. An exaggeration of the normal retroflexion and retroversion of the head and neck is shown. Either number 1 or number 3 wire would act as a guide, but number 2 wire would direct the nail through the anterior articular surface of the head, although it is perfectly situated in regard to front and posterior aspects of the neck. The angle of the head and neck to the horizontal plane (with the patient lying supine this plane is represented by the bicondylic line through the front of the femoral condyles) depends upon such components as the rotation of the proximal end of the femoral shaft, the angle of the neck to the base of the trochanter, the flexion of the neck itself, and the ante- or retroversion of the head upon the neck.

In Figure B ideal reduction is absent (see Figure LII) and pressure on the forward projection of the neck *plus* lateral traction (see Figure XVII) has been neglected.

In Figure C there is retroversion of the head due to crushing of the posterior aspect of the neck, leaving a gap there when the limb is internally rotated (dotted outline).

Figure D represents the same case as in Figure C, but strong internal rotation and manipulation of the neck reveal the typical defect on the back of the neck. Number 2 guide wire forms an angle of 15° with the horizontal plane.

of soft subcutaneous tissues and muscles from the actual head and neck of the femur. Consequently a distorted projection of the lead markers will follow any alteration of the position of the target of the X ray tube, especially if the target has not been centred accurately over the head of the femur, which can easily occur between the series of X ray exposures if the tube is altered. Thereby the accurate introduction of the wire becomes very difficult. H. J. Besselaar and Friedland (Pretoria) have determined the target point in the head at which to aim the wire in the following manner: A line is dropped vertically (in the long axis of the body) from the mid-point of Poupart's ligament until it meets at right angles the horizontal line drawn through the superior border of the pubic crest. This meeting point is the target point, but the thighs must be flexed to 20°, otherwise tilting of the pelvis alters the position of the horizontal line. This immediately introduces a source of error. Any method of obtaining the surface markings of the head other than direct palpation in a thin subject can be only approximately accurate. The method which I have advocated of placing a guide wire in the soft tissues behind the neck under direct vision with the fluoroscope is the most accurate (Figures XXXVI and XXXVII). The estimation of the inclination or angle of the neck and head and its importance in the drilling of the wire so that it penetrates the bone approximately between the front and back surface of the femoral neck, is discussed later.

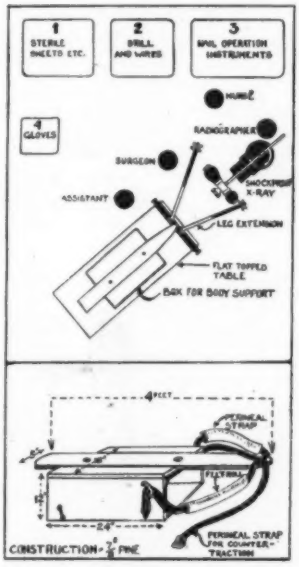


FIGURE VIII.

Plan of arrangements in theatre. The wooden box for supporting the trunk is strapped to an ordinary operating table, to which leg extension pieces have been clamped. The box is important because it provides counterextension from the perineal straps without any central metal perineal bar to obstruct the fluoroscopic examination of the hip. These straps not only prevent tilting of the pelvis, but also hold the patient firmly when the nail is being hammered into the bone and during impaction of the fracture.

Experts in hip surgery refer to the intraarticular or open method of osteosynthesis as a difficult one. Smith-Petersen, who has performed more than fifty operations, admits this. What is the reason for this? The exposure of the hip joint, although a major procedure, can present usually no difficulty at any rate to a surgeon who frequently operates on

this region. Hæmostasis is, of course, sometimes troublesome. The reduction of the deformity under vision should be easy. It appears that the difficulty is the accurate introduction of the nail, even under vision. Consequently at least two surgeons (Watson Jones and Seidel) are using a canaliculized nail driven along a wire guide, even though they are using the large Smith-Petersen incision. Also Stirling (Edinburgh) recommends a holder punch for guiding the nail in the open operation in order to insure "first time" correct introduction of the nail. Others, including Littlejohn (Melbourne), have used a similar punch. One end of the impactor that we use can be used for holding a nail. The use of the guide wire and canaliculized nail with the open operation has the same objective because it overcomes the possibility of one or two attempts to insert the nail properly. It can be conceived that when the nail is eventually precisely inserted after more than one attempt, it may not hold very well. The previous attempts have caused some destruction of the cancellous bone. One of the advantages of extraarticular osteosynthesis is that, despite occasionally several attempts to place the guide wire correctly, only one essay with the nail is necessary, because it should be correctly placed if the preliminary guide wire has been.

FIGURE IX.

Diagrams of the usual deformities.

1. Frontal view of a typical subcapital fracture showing shortening, external rotation and adduction. The smaller diagram of the X ray view shows the approximation of the dense posterior intertrochanteric ridge to the acetabulum. Thereby a false impression of an impacted trochanteric fracture can be produced.
2. Lateral view showing the usual deformity. The fractured surface of the distal fragment looks forward and is at right angles to the fractured surface of the head. The forward projection of the neck may injure the front of the synovial membrane or capsule. Thereby temporary (some months) pain and limitation of movement can follow, owing to contracture, despite extraarticular osteosynthesis. If the fragments have a long "spike" attached to either, this may project through the hole and the resultant "buttonholing" can cause difficulty in reduction.
3. Lateral view showing the more unusual deformity with the distal fragment lying behind the head. Therefore the distal fragment should be externally rotated as a routine step in the manipulative reduction. Then if this deformity is present, but has not been recognized because a lateral X ray examination was not made, the case is converted into one similar to that in the last figure. This is important because the last stage of the reduction by strong internal rotation assumes that the neck is looking forward as in the previous drawing.

That bone pegs and nails have been misdirected when the neck of the femur has been exposed by an anterior incision and when the femoral shaft has been exposed just below the great trochanter by a lateral incision is well known. Stirling Bunnell, in this regard has stated:

> Some are naturally so gifted that they can usually drill the hole for the peg or can hammer the nail blindly straight through the narrow (2·8 centimetres) neck of the femur and into the centre of the head, but there are instances aplenty when the peg or nail missed the central course and was demonstrated by X ray to be seen outside the neck or head, resulting in intense anguish to all concerned.

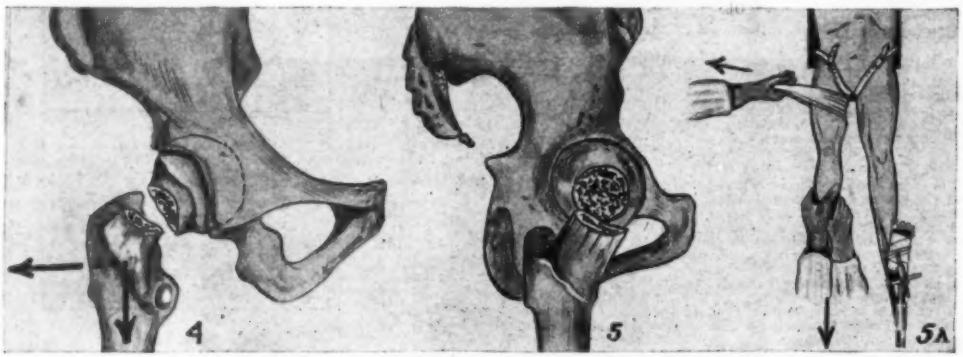


FIGURE X.

4. Frontal view after the shortening has been corrected by longitudinal traction combined with lateral traction as shown in 5A. Note the exaggerated gap between the fragments.
5. In the lateral view the distal borders of the two fragments are on the same level. Otherwise there is no change from the corresponding diagram in Figure IX.

5A. Note that although the "good limb" is held by the foot piece of the leg extension apparatus manual traction is being used to overcome the shortening. Thereby overextension is avoided. As soon as the reduction is complete the limb is attached to the leg extension.

He has devised an ingenious sight for accurately directing the dowel peg. Melvin S. Henderson, for old ununited fractures, despite an open incision of the joint which is necessary for freshening the bone surfaces, also checks up the introduction of a whole thickness fibula transplant in the following interesting manner. A Kirschner wire is drilled through the neck and head just into the acetabular cavity of the joint. Lateral and frontal X ray pictures are made to check its central position. Then a cannulated drill is bored along the wire into the bone so that a channel is made for the fibular peg. The medullary cavity of this tubular bone is used for directing the

FIGURE XI.

6. Frontal view showing restoration of Shenton's line by correcting the adduction deformity, when the limb is moderately abducted. Nevertheless a perfect reduction can be obtained without any abduction.
7. Lateral view showing the typical deformity before internal rotation has been performed.

peg into the head of the femur along the wire, although once the hole in the neck and head of the bone has been made the graft should proceed accurately. The occasional difficulty in inserting the nail, despite the large Smith-Petersen wound, is due to the fact that even with this huge wound the lateral aspect of the proximal end of the femur is not readily accessible, although internal rotation brings forward the great trochanter. Similarly, introduction of the nail for intraarticular arthrodesis of the hip joint as recommended by Watson Jones is more difficult because the limb must be fixed with some external rotation of the femur for subsequent function. Hence Henderson's method of reversing the Smith-Petersen skin flap is an advantage (that is convex backwards instead of forwards). If the musculo-tendinous juncture of the *tensor fasciæ femoris* muscle is distal to this area, then the muscle belly which has been divided already from its iliac origin must be wholly or partly divided through muscle fibres again, opposite the lesser trochanter. Alternatively the dorsal skin flap can be dissected up until the lateral aspect of the femur, covered by the *tensor fasciæ femoris* and *vastus externus* muscles, is exposed or a separate incision is made. In any case it is not always very easy fully to display the front and back borders of the bone. This difficulty, of course, has a very important bearing in driving the nail correctly so as to respect the torsion angle of the femoral neck. This suggests a simpler and easier method of intraarticular osteosynthesis which I intend using should extraarticular osteosynthesis be contraindicated because of non-reduction owing to failure of closed methods, or for old ununited fractures. A small anterior arthrotomy incision is used because the smaller the incision the less the danger of infection and disturbance of the local blood supply. Then the reduction of the deformity is performed. Although the wound is only 7·5 to 10·0 centimetres (three to four inches) long and no skin flaps are dissected up, the view of the fracture site is displayed by using strong sharp-pointed double-pronged retractors. These are the secrets of the successful exposure. A small sharp single hook is used to correct rotation or to pull out any capsule *et cetera*. Lateral traction (see Figures XIV, XV and XVI) is used to separate the fragments, and thus facilitates manipulation which brings the fractured surfaces together. A lateral incision over the proximal end of the femur is then made. Again with a sharp hook retractor, the bone is exposed by holding aside the skin edges and deeper muscle or aponeurotic fibres. A wire is then placed along the front aspect of the femur from the lateral incision. By inspecting its position through the anterior incision it can be placed near the lower third of the front of the neck. Now, through the lateral incision a wire is drilled into the neck in the same direction as the first one, but when it has entered about five centimetres (two inches) the thigh is externally rotated so that the operator can watch for the appearance of the wire at the fracture site through the distal fragment. If the wire has

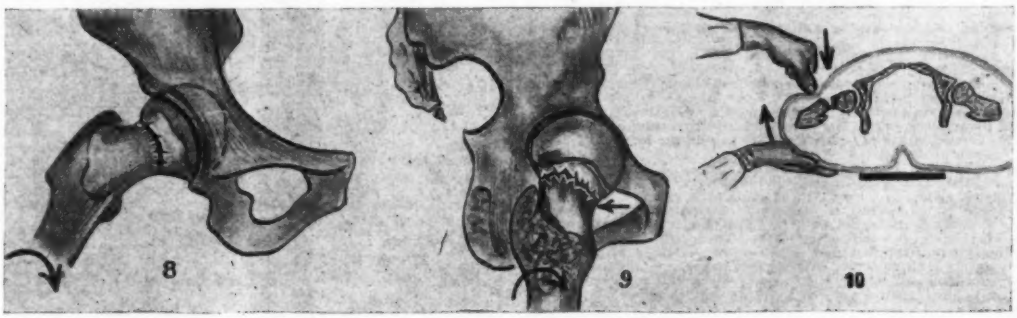


FIGURE XII.

8. Frontal view showing closure of the gap between the fragments, on their anterior aspect, by strong internal rotation.
9. In the lateral view not only has the gap been "taken up", but the forward displacement of the neck has been pressed backwards by the thumb as in the next diagram. Thereby the front and back borders of the two fragments are in the same line restoring the original contour of the neck.

been correctly directed up to this point, then the limb is internally rotated and the wire is continued into the head. The estimated length of the wire to be drilled is measured from the length of the first wire lying across the front of the neck. The nail is then easily and certainly driven into the neck and head.

Indications for Operation.

The indications for operation are very broad because the extraarticular method submits the patient only to a minor surgical procedure. Although the operation is seldom performed under one and a quarter hours, and may take two to three hours, the extra time does not accentuate the seriousness of the procedure because lumbar or local analgesia obtained by "Decicain" or "Percaine" lasts in any case for two to three hours.

The patient is usually semi-conscious ("twilight sleep"), but is easily awakened for drinks, and can be made comfortable and kept warm on the padded special box which acts as a body support.

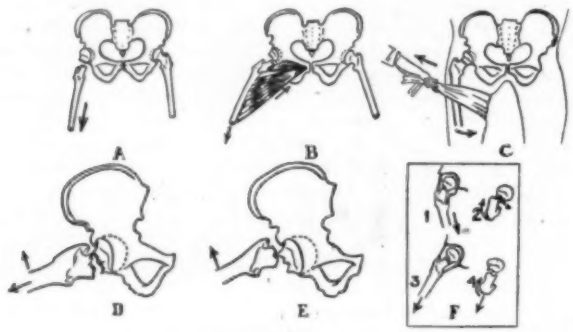


Figure XIII.

Illustrating some difficulties in reduction of the deformity.

A. Overextension has been caused with a valgus position of the head and neck.
B. Overextension *plus* excessive abduction results in the distal fragment lying underneath the femoral head.
C. Correction of the last disability has been obtained by removing all extension and abduction and using the lateral traction alone. Adduction assists the latter. Even then reduction may be very difficult if there is a "spike" attached to the neck, which has "buttonholed" the capsule.
D. Excessive abduction has caused a V-shaped gap on the lower part of the neck.
E. Excessive abduction has been carried out before the shortening was corrected. Reduction is then practically impossible.
F. Diagrammatic figures to show that abduction alone, without the addition of the lateral traction, can be helpful in association with the other manœuvres of manipulative reduction: 1. Frontal view showing correction of the shortening, but adduction deformity is still present. 2. On attempting internal rotation first before abduction the head is rotated backwards. 3. With moderate abduction, however, *plus* the longitudinal traction, a slight gap tends to develop between the surfaces. Strong abduction would of course tend to have the opposite effect because the adductor muscles are stretched. Longitudinal traction with slight abduction tends to pull in the long axis of the neck and separate the fragments (see Figures LIII and LVII). 4. Internal rotation can now occur without the fractured surfaces of the distal fragment impinging upon the front of the head as in 2.

Consequently the patient might just as well be in the operating theatre as in bed in the ward. Early operation will be considered (that is after one week) if bed sores are present when the patient is first seen, otherwise the recumbent position will favour the development of sepsis. Decubitus occurs when poor old women with these fractures remain at home for a week or more before admission to hospital. In these cases we can allow the patient to sit up in a chair two or three days after the operation. The presence of a bed sore on the buttocks or sacral prominences should not contraindicate operation; rather the reverse, because patients can be allowed to sit in a chair soon after the operation. The

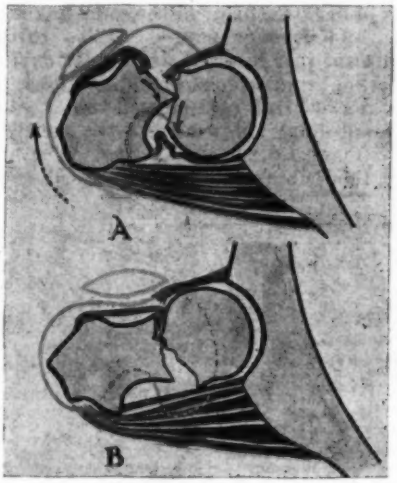


Figure XIV.

(*After* Tavernier.)

A. Lateral view of subcapital fracture. The lower fragment is externally rotated. The large arrow indicates the direction of internal rotation.
B. Internal rotation of the distal fragment (trochanteric) has caused backward rotation of the *caput femoris*. Capsular fibres intervene and the reduction is very poor, although the frontal view of this might show apparently satisfactory reduction.

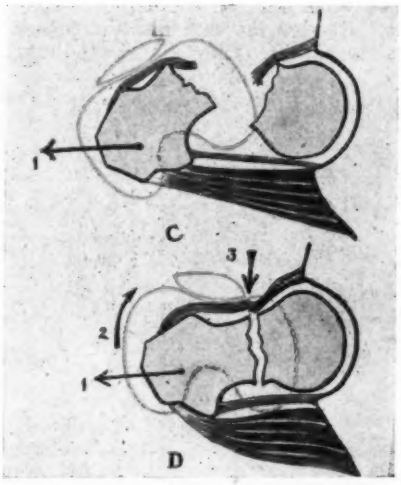


Figure XV.

(*After* Tavernier.)

C. Lateral view of a subcapital fracture in which lateral traction (1) indicated by the arrow (with a towel around the adductor region, as in Figure XVI) has caused a separation between the two fragments.
D. Same as C, but lateral traction is being maintained less strongly because internal rotation (arrow 2) and thumb pressure (see Figure XVII) on the anterior projecting end of the neck (arrow 3) have resulted in reduction of the deformity. The two fragments were not in contact, at least firmly, during this manœuvre.

operation wound is only about five centimetres (two inches) long, and is a considerable distance from the septic area. In such cases a specially careful aseptic technique is necessary. The skin incision having been made, protective sheets of rubber dental dam are quickly clipped to the skin (and not sewn on—a procedure which is time-consuming and results in considerable handling of the skin). Of course a fresh knife is then used for division of the deeper structures.

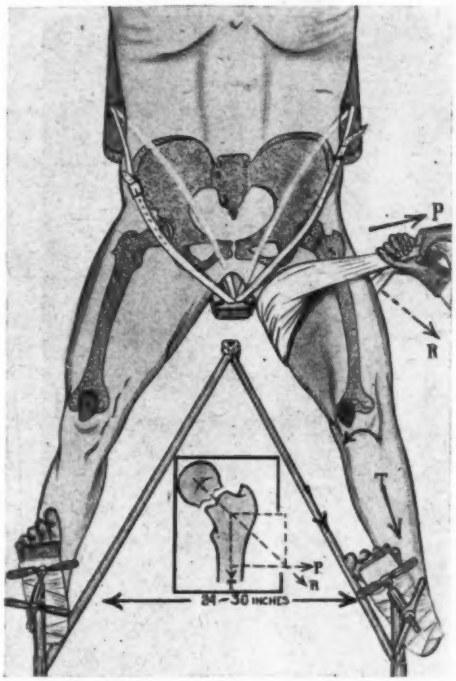


FIGURE XVI.

The patient is represented lying on the box for supporting the trunk, countertraction being obtained by the two perineal straps (well padded). Traction is maintained by the extension leg pieces and lateral traction by the loop around the groin. Internal rotation has been completed vigorously, then released slightly so that the patella looks inwards about 25° to 45°. The limbs are abducted so that about 60 to 75 centimetres (24 to 30 inches), and no more, is the distance between the ankles. Inset drawing (after Robineau and Contremoulins) shows that if traction is obtained on the distal fragment by two forces, one T in the long axis of the limb and the other P at right angles, then the resultant of the two forces R is a direct pull in the long axis of the neck.

CONTRAINDICATIONS.

Contraindications are very few indeed. They may be enumerated under several headings:

1. Fractures self-impacted in abduction (Böhler) or *coxa valga* (Kocher), as in Figure XXVII. The question of "impacted fractures" brings to consideration two distinct and different types of this definite clinical condition, that is non-penetrating fractures or pseudo-impaction "in adduction" and penetrating fractures or true impaction "in abduction". The first type of impacted fractures is not truly or strongly impacted. The bone has either not completely fractured or else the fragments are temporarily locked, but the fragments are insecurely "impacted in adduction", with a varus deformity, a position which clearly is an unstable one (Figure XXVIII). The rule is for the fragments to separate after a few days, especially if walking has been carried out. The lateral X ray view will often show far more damage than that seen in the frontal X ray view. In the second "impacted" type the fragments are truly driven, often firmly, into one another in the abducted position and a valgus deformity results (Figure XXVII). There is no doubt whatever as to the existence of this condition, although it has been denied. Years ago Helferich showed a *post mortem* specimen, and within two years I have treated six cases of this type by merely resting the patient in bed. Böhler states that 20% of subcapital fractures are of this variety. Apparently they are often overlooked because no X ray examination has been made. The fragments in my six cases did not become unlocked. All were, however, of the valgus type, as described by Kocher and Waldenström, and not of the varus type. Mouchet and Mouchet, with a characteristic Gallic touch, have called these impacted fractures in abduction with *coxa valga* "latent" fractures of the femoral neck and recently reported four cases. In their article they gave thirteen references to the literature, which contained further examples. Lecocq and Lecocq recently described a typical case in which the patient walked from the first and did not lie up at all. A later X ray picture showed union. Also interesting was the new subperiosteal bone on the lower aspect of the neck, showing that these fractures unite not only by internal callus. Such a valgus deformity, of course, is compatible with perfect function, provided the lateral view does not show severe rotation and displacement of the head in relation to the neck. When this displacement is due to crushing of the bone, with no actual dislocation of the

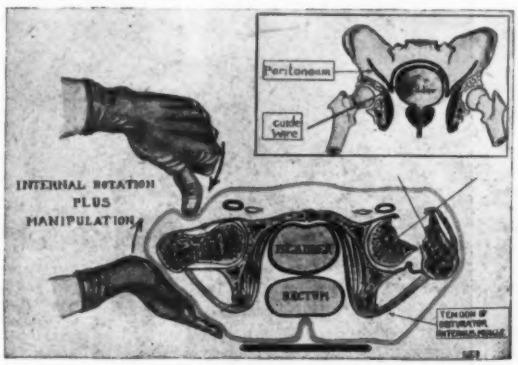


FIGURE XVII.

Diagram showing the cross-section at the level of the hip joint. On the left side internal rotation and lifting forwards of the trochanter have been completed by the right hand behind the femur and the left thumb pressing very strongly backwards on the forward projection of the fractured surface of the lower fragment. On the right side the sharp anterior margins of the fractured surfaces have ruptured the capsule. The theoretical effect of the *obturator internus* muscle (and similar pelvi-trochanteric muscles, not illustrated) in causing shortening and external rotation is seen; also the relationship of the femoral vessels to the front of the hip joint.
Inset.—This shows the result of a guide wire being drilled into the pelvis. The bladder, rectum, small intestine and even the iliac vessels could be injured.

fragments, it obviously cannot be corrected. Secondary deformity of the head is then inevitable.

The first type is treated by osteosynthesis after reduction. The second type does not require this unless the lateral X ray picture demonstrates severe deformity, but I have not seen a case requiring it. It would be an imprudent act to "break up" this type of impacted fracture.

2. The moribund patient, for example one suffering from uræmia or cerebral hæmorrhage.

injury. S. Harild has also reported a recent dislocation of the hip associated with a small piece from the head remaining in the acetabulum.

In this case the neck was fractured during attempts at reduction. Harild removed the head at operation, although the patient was only thirty-three years old, and a labourer. He used a posterior incision and the head was in three or four fragments, one in the acetabulum being attached by the *ligamentum teres*. Fifteen months later the patient could not walk without a stick, and had two inches of shortening of the limb. The disability was estimated at 38%.

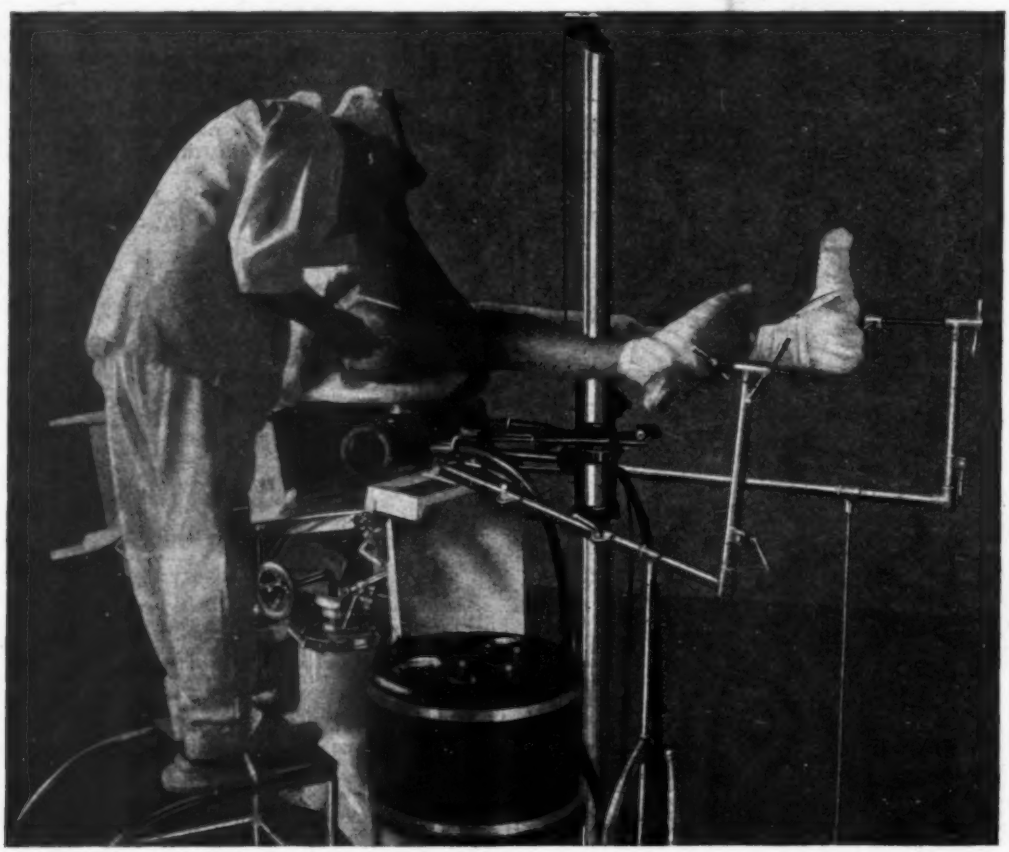


Figure XVIII.

The crux of the operation is shown because under fluoroscopic vision a Kirschner wire is thrust through the soft tissues behind the neck of the femur, near the lower third of the neck and parallel with it. The neck can always be clearly seen, and the head, although not always clearly seen, is indicated very precisely by the upper and lower margins of the acetabulum, which are easily seen even in a 100 kilogram (approximately 16 stone) patient. The length of the wire projecting beyond the skin not only indicates with great precision the neck-shaft angle, but also indicates less accurately the torsion angle of the neck and head of the femur.

3. The presence of multiple injuries such as fracture of the pelvis and visceral injuries.

4. Severe splintering and comminution of the head of the femur. For this type of injury reduction and then immobilization in a Whitman's plaster cast are indicated.

5. Irreducible dislocation of the head associated with fracture of the neck. This is a rare injury. Open reduction would probably nearly always be required. The recent account of A. K. Henry and M. Bayumi is a notable contribution concerning this

He mentions a number of similar cases recorded by others. In Lisfranc's case the fracture followed the attempts of ten assistants pulling together as one on the limb, whilst Wipperman's case from Czerny's clinic resulted from the well intentioned efforts of four assistants, all attempting at one time the reduction of the dislocation!

6. When the bone is very atrophic, a condition which occurs in very old and feeble subjects, the nail does not hold very well. Unfortunately this can be determined with certainty only at operation when one drives the nail into the bone very easily.

In these cases the replacement of cancellous bone by fat and the decalcification of the compact bone, especially of the *calcar femoralis*, may be followed by failure of any form of treatment because the bone is so atrophic (Figures XXXVI to XLV). In one case in which the bone was very soft one blow of the hammer resulted in the nail penetrating it like cheese. After I used the impactor, instead of the nail head "standing out", the nail continued its course and passed into the pelvis (Figure XXXII). In this type of case it has been proposed by Anschütz to drive the nail right through the head and nail it to the floor or sides of the acetabulum, although the former is very thin. It would provide a rather insecure grip for the nail, but it has been used successfully by Hocht with a pelvi-trochanteric screw, and is recommended by Hillibrand, Richard and others. This method appeared to have had a number of adherents in Germany, but now has been largely supplanted by the three-flanged nail. Strangely enough good functional results have been described, even though the point of the screw was still in the floor of the acetabulum more than a year later.

When the bone is soft, I deliberately drive the nail end just through the cartilaginous surface of the head. Thereby the whole of the denser bone of the head is engaged. Providing movements are carried out within that range in which the projecting nail does not impinge upon the peripheral articular surface of the acetabulum, pain does not result. After three months the nail can be slightly withdrawn, but not removed.

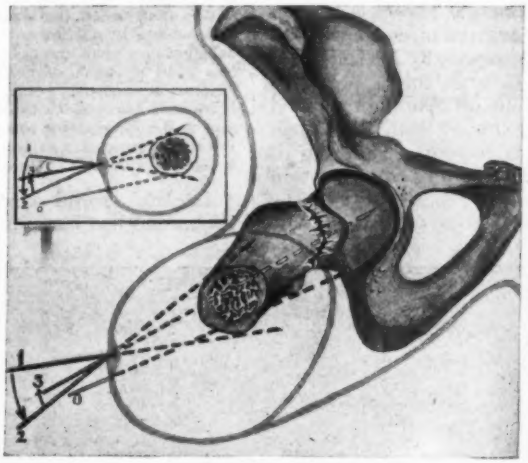


FIGURE XIX.

Method of drilling a guide wire into the neck and head of the femur without a preliminary skin incision. The diagram represents the inner aspect of the femur, looking into the perineum. The object is to determine that point on the lateral aspect of the femur, approximately mid-way between the front and back surfaces of the bone, where the guide wire is to be drilled.

Number 0 is the guide wire behind the neck, placed there under fluoroscopic control.

Numbers 1, 2 and 3 are representations of the various positions of a single guide wire we wish to insert into the bone. This wire in position 1 has been thrust just behind the neck. Then it is withdrawn slightly and now thrust just beyond the front border of the neck as in 2. It is withdrawn slightly again and then thrust on to the lateral aspect of the femur mid-way between positions 1 and 2. Thereby we have obtained information by the tactile sense and we can drill the bone without any preliminary incision over the lateral aspect of the femur mid-way between the front and back surfaces of the bone. Thereby X ray examinations are facilitated, asepsis is more easily maintained, and time is saved because successive drapings of the wound with sterile towels are not required after each X ray examination.

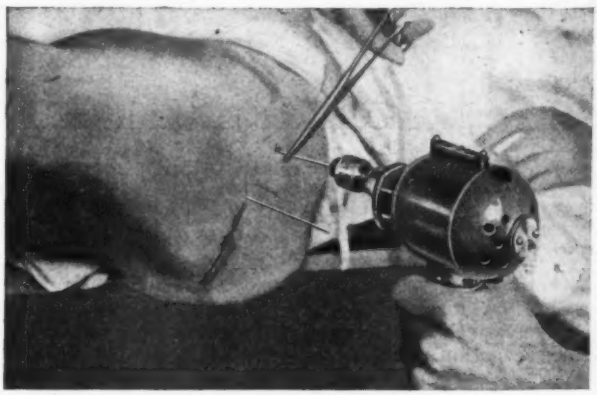


FIGURE XX.

The lower wire has been introduced behind the neck according to the method shown in Figure XVIII. It indicates precisely the neck-shaft angle and also the declination angle approximately. Note that by using the artery forceps instead of the collapsible guide (not shown) for preventing "whipping" of the drill wire, it is very easy to "sight" the other wire behind the neck. Also, this makes it possible to drill in two or more wires within an area about the size of a threepenny piece.

7. The association of osteoarthritis of the hip joint has been often noted by surgeons who performed arthrotomy for introduction of the nail. This will not necessarily be a contraindication to extraarticular osteosynthesis, even if it is so gross that it is evident in the first diagnostic X ray picture. Owing to excessive vascularity of the head as a result of arthritis, on theoretical grounds union seems more likely.

8. Lateral or trochanteric fractures. In general these fractures are unsuited for transfixion by a nail because of the severe splintering. Furthermore with pertrochanteric fractures there is insufficient bone in the distal fragment to support the nail. However, fractures without any comminution just at the base of the neck are ideally suited for the nailing. I have never, as yet, operated on a trochanteric fracture, although a number of such cases are always under treatment.

The Operation of Extra-articular Osteosynthesis for Non-Union.

From the point of view of using the method for non-union, two distinct classes of case may be recognized.

In the one no treatment whatever has been carried out. For example, the patient has been allowed to sit in a chair and has even been urged to walk very soon after the injury. In such cases a weak fibrous union results. The capsule and "Y" ligament become stretched and hypertrophied and intervene between the fragments. Those who advocate the early mobility with a walking caliper of patients perfectly capable of withstanding more deliberate treatment, aim at this highly unsatisfactory state of affairs. Before a decision is made as to what is to be done in such a case, an antero-posterior X ray picture, with the limb internally rotated, is first of all made. If this reveals absorption of the neck of the distal fragment, then it may be assumed that the hyperæmia of the trochanteric region has

caused decalcification of the bone and that in such a case the neck has been replaced by a considerable amount of tough fibrous tissue which is the fibrous matrix of the bone now remaining. The case is then probably unsuited for a conservative measure such as extraarticular osteosynthesis, especially if the head seems dense and " chalky ", because this appearance indicates that the head is cut off from any blood supply. If anything is to be done at all, then open operation is necessary, but is beyond the scope of this discussion. This brings up for consideration the question as to how long after the receipt of the fracture injury extraarticular osteosynthesis can be safely performed with a prospect of bony union resulting. Considerable absorption can occur after three months if there is a lack of immobilization, the absence of which tends to increase the hyperæmia of the neck and accelerates its absorption. Johansson obtained bony union in one case eighteen months after fracture in a patient of thirty-five years of age, treated in the first instance by the Whitman method, which failed. After the nailing bony union resulted in three months. Böhler was successful with a patient aged forty, the fracture being of eighteen months' duration.[1]

In two instances I drilled a few holes with the wire into the neck and head, which were then fixed by extraarticular osteosynthesis; whether union will occur remains to be seen. Presumably there was considerable fibrous union because the neck was absorbed, but there is no gap now between the fragments which were firmly impacted. This fibrous tissue may become calcified now that immobilization has been attained. Nevertheless good prospect of bony union probably depends upon the amount of absorption of the neck of the femur, which, as stated, is an indication as to the fibrous tissue between the fragments and is determined by the frontal X ray picture with the limb internally rotated, the full length of the remaining neck being thereby displayed. The operation is safer than this.

In the second class of case, apposition of the fragments has been maintained by a splint or plaster cast or by a three-flanged nail which has failed to prevent a loosening of the fragments, but non-union has resulted. In this type of case a large amount of fibrous tissue could not have been formed between the fragments because their surfaces were more or less approximated. The neck will not be nreatly absorbed. Therefore decalcification of bone had its simultaneous conversion into fibrous tissue aftre not occurred. Here the prospect of union gave extraarticular osteosynthesis would appear to be good because intervening fibrous tissue has been largely avoided. The firm wedging of the fragments into one another by the impacting instrument is a special feature of these secondary operations.

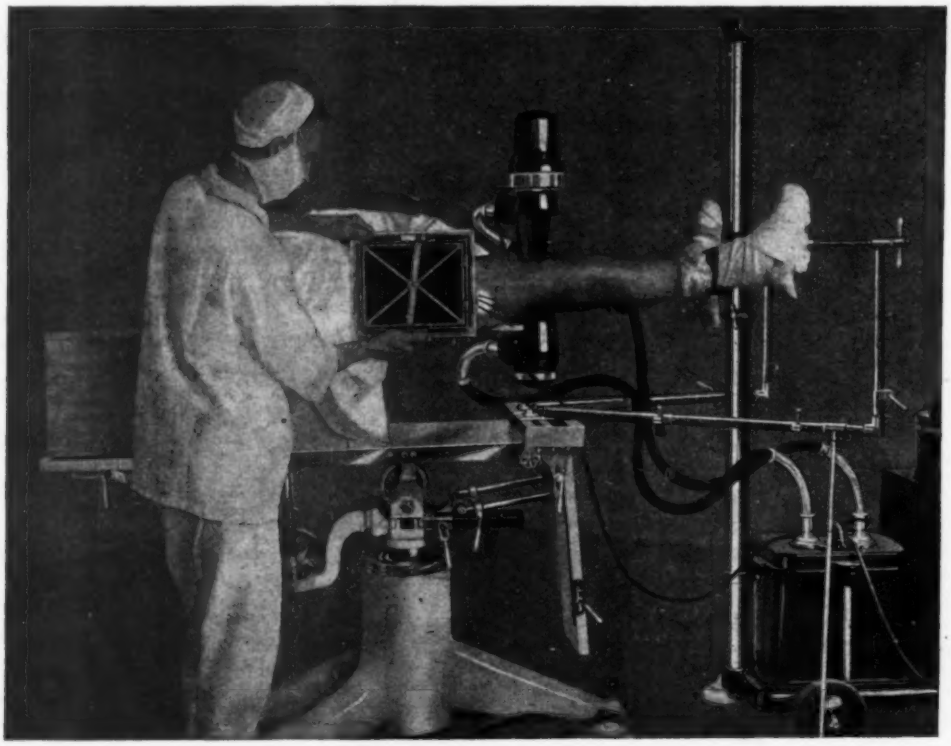


Figure XXI.

A lateral X ray examination is being made with the Philips " Metalix " shock-proof mobile X ray unit. One wire is seen behind the neck, and two others have been drilled into the bone at slightly different angles. A piece of gauze has been wrapped around their puncture entrance into the skin.

[1] He has just reported seven united fractures treated by extraarticular osteosynthesis, four being so far successful (*Zentralblatt für Chirurgie*, 1935, page 1756).

More experience is necessary before any further opinion can be offered. In these old cases of non-union (after six to twelve months) in which we perform arthrotomy for freshening of the fractured surface, one cannot fail to be impressed by the almost insuperable opposition to bony union offered by the large amount of intervening fibrous tissue, especially in cases of pseudarthrosis. One could not, in these circumstances, conceive that extra-articular osteosynthesis would be of any real value. but it deserves a fair trial.

X Ray Examination of the Hip Joint.

An antero-posterior X ray picture is made soon after admission of the patient to hospital. If this X ray picture is made with the limb very outwardly rotated ("everted") the dense posterior inter-trochanteric ridge becomes approximated to the acetabular rim. Since the external rotation twists the fractured surface and the neck forward, the neck overlies the head and an appearance simulating a

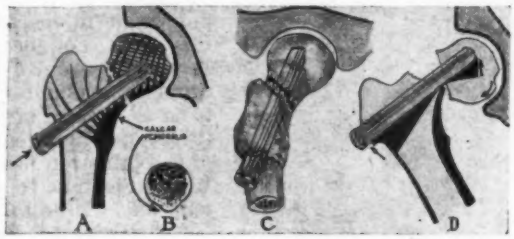


FIGURE XXII.

A. Frontal view: The nail has been driven into the neck and head, in the lower third, so that it lies on the denser bone of the *calcar femoralis*. This is ideal.
B. The open "V" of the "Y" looks cranially, so that the broadest surface of the nail looks upwards. Thereby the tendency for the nail to cut into the bone in an upwards direction, with resultant *coxa vara* deformity and loosening of the fragments can be counteracted.
C. Lateral view: In this plane the nail lies ideally mid-way between the front and posterior surfaces of the neck of the femur.
D. Frontal view: The nail has loosened despite perfect introduction, cutting into the bone vertically above it. If the bone is atrophic, this may be inevitable. Early weight bearing under six to eight weeks tends to the same result. The nail is nearly horizontal, but this is masked by the adduction deformity. The nail is also cutting upwards into the head, which is dense. The two fragments will soon become separated altogether. Then the end of the nail will lie above the acetabular rim on the ilium.

trochanteric fracture can be given. Therefore traction on the limb should be gently and steadily exercised by an assistant who grasps the ankle, and then the limb is slowly internally rotated. If this is done carefully, very little discomfort results. This manœuvre is very important for the correct diagnosis of doubtful impacted fractures situated near the base of the neck, because the antero-posterior picture with the limb internally rotated demonstrates fully the whole length of the neck and the site of the fracture.

It may be necessary to administer a brief ethyl chloride anæsthesia or else to inject twenty cubic centimetres of a 1% "Novocain" solution into the joint as a preliminary.

The lateral X ray pictures are very important because this view demonstrates (i) the torsion angle, that is, the usual forward inclination of the head and neck of the femur on the shaft; (ii) the main deformity, that is, the buckling and compression of the dorsal aspect of the neck; (iii) callus, seen earliest on the anterior aspect of the neck (of the distal fragment; it can therefore be seen only in this view).

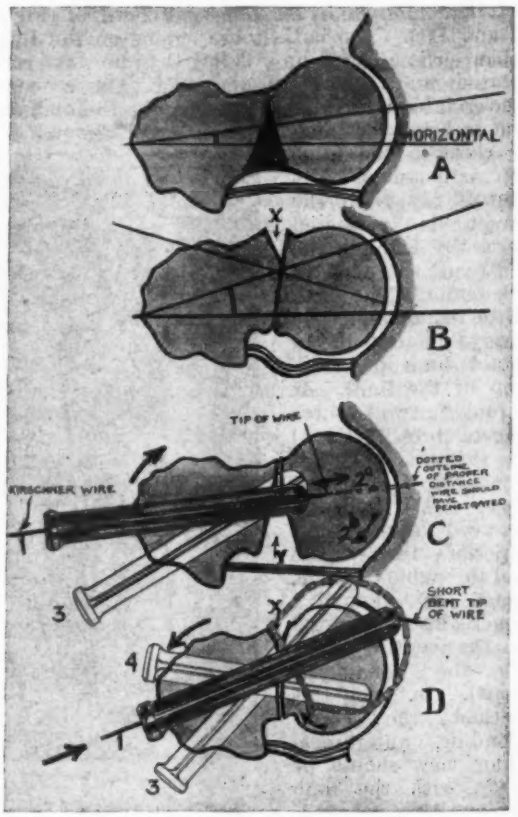


FIGURE XXIII.

A series of diagrams of the lateral aspect of the femoral head and neck to illustrate a difficulty in introducing the nail. The posterior aspect of the neck has been badly compressed by a buckling injury. The guide wire has not been drilled far enough into the head, and therefore can be bent more easily by inaccurate driving of the nail, especially if the nail head is hit too hard.

A. Typical compression fracture with the posterior crushing defect after reduction of the deformity.
B. Same as above before reduction.
C. Same as above after internal rotation. Note the posterior defect Y. Nail 1 is of correct length, and is being directed along a perfectly inserted guide wire. This nail should not enter the hip joint. However, as soon as it strikes the dense head the latter may rotate backwards (arrow 2b) because there is no bony engagement between the fractured surfaces on their posterior aspect. Furthermore the guide wire can bend at the tip because it just penetrates the head and has not gone deep enough. The head rotates backwards as soon as the nail strikes it, bending the guide wire, which is now driven forwards into the hip joint as in Figure D. Nail 3 shows another direction in which the nail could have been driven. It would have less tendency to cause rotation of the fragments.
D. Same as above, but the defect behind has been closed up due to the rotation backwards of the head by the nail. A small anterior defect X now reappears. The nail is too long now, and has entered the acetabulum. In such a case a nail directed as in nail 4 would engage both fragments without this difficulty.

Sometimes in the antero-posterior view the deformity appears to have been corrected after manipulation, but the lateral view may not confirm this. Stereoscopic views are of little value. Furthermore a stereoscopic view made in an antero-posterior

direction cannot show any more detail of bone structure than is seen in the single picture. The bone structure on the front and back aspects of the neck of the femur can be properly appreciated only in the lateral view.

The following four methods for obtaining this view have been used:

1. *Examination in the Lithotomy Position* (Figures II and III). The patient lies supine on the Bucky table. The affected limb is flexed to 90°, externally rotated and somewhat abducted. On a curved Bucky table it is desirable to increase the abduction and to bring the thigh as close to the table top as possible. The central ray from the target is projected vertically through the centre of the head of the femur. The head of the femur can nearly always be felt in an intact limb on rotation of the limb. It is roughly two to three fingers' breadth distal to the mid-point of Poupart's ligament (that is mid-way between the antero-superior iliac spine and the pubic tubercle, which is about a finger's breadth lateral to the central point of the *symphysis pubis*). In using this method the corresponding antero-posterior view should be made with the limb internally rotated. Then the view is an absolutely true lateral one, because the frontal view is made with the limb lying on the horizontal plane of the table, and the other view is made with the limb at 90° to the last plane, that is, vertical. Since a Bucky diaphragm is used, the X ray pictures give beautiful bone detail. No distortion of the neck or head is caused. It is the best method, but is unsuitable if the hip cannot be flexed or, in the case of a fracture, before the fragments have been nailed together.

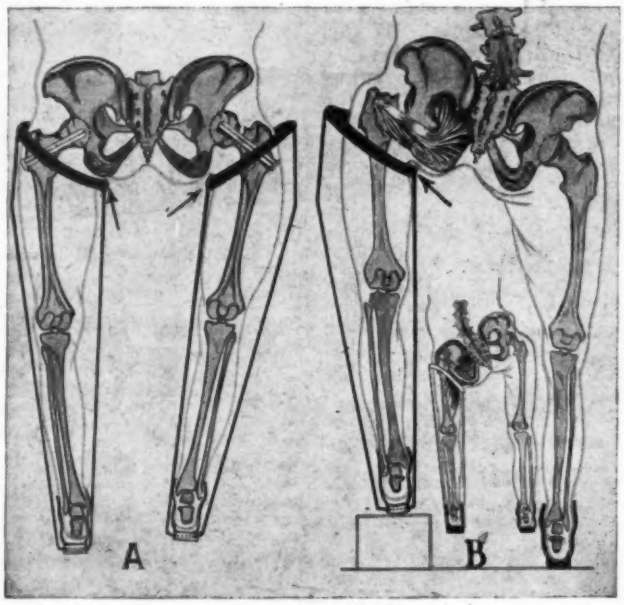


Figure XXIV.

A. The diagram of the left limb illustrates how the ring of the Thomas walking knee caliper splint is relieving weight from the fractured neck of the femur, which has been transfixed by a Smith-Petersen nail. On the right side the ring has slipped off the ischial tuberosity and the splint acting as a long lever has strained the fracture line. A loosening of the fragments is beginning to occur.

B. Both drawings represent an old ununited fracture of the left femoral neck. The distal fragment lies behind the head, and there is considerable shortening. The gemelli and *obturator internus* muscles are shown very elongated and hypertrophied. Both drawings show how in such a case the "weight-relieving" caliper is ineffective, because the ring has not remained against the ischial tuberosity. The thrust of the ring then exaggerates the adduction deformity and causes a "functional shortening" (Hey Groves) so that the compensatory scoliosis over and above that necessary to control the real shortening makes walking very difficult indeed (see large drawing). The smaller drawing shows the compensatory scoliosis which is necessary to overcome the actual shortening caused by the upward displacement of the lower fragment upon the *dorsum ilii*.

2. *Lateral View on the Bucky Table* (Figure IV). The view obtained by this method is very good, and shows perfect bone detail. It is more difficult to obtain than the previous one, on account of the difficulty in projecting the central ray correctly. It has the advantage that there are few patients who cannot lie on their side. There will be difficulty when there is an adduction deformity present, for example tuberculous coxitis.

Since the lead strips of the Bucky diaphragm are disposed in the same direction as the long axis of the table and as the diaphragm moves across the same long axis, the tilt of the target towards the long axis of the lead strip does not affect the rays passing through the grid. But, on the contrary, if the target is tilted in the opposite angle, that is, across the table, then it will be almost impossible for the rays to pass through the grid. Thus if it is found that the exposure must be increased many times in order to obtain a picture, which even then is not clear, then we can be sure that the tube is tilted across the Bucky and that the central ray has been directed some distance to either side of the mid-line of the Bucky diaphragm. Therefore it is very important to see that this does not occur. It can be avoided by dropping a plumb line from the centre of the target to the centre of the table top before tilting the tube to the long axis of the table.

3. *Perineal View* (Figure V). The uninjured limb is flexed at 90° out of the way. The central ray from the target is directed from a distance of four feet into the angle which the thigh makes with the perineum, that is, on to the neck of the femur midway between the head and the great trochanter. The horizontal level of the target should be the same as that of the great trochanter which is easily felt. It has been advised that the central ray should be at right angles to the long axis of the neck of the femur and that the casette should be parallel with the neck (inset Figure II). We have obtained less distorted pictures when the casette lies directly on the skin over the outer aspect of the thigh, because the film is much closer to the part to be photographed. Even then almost the slightest alteration in projection of the rays on to the casette has resulted in errors of distorsion and exposure times and failure to show the head. These difficulties disappeared when Dr. John O'Sullivan, radiologist to Saint Vincent's Hospital, Melbourne, suggested that the technique be considered

as similar to that used for obtaining dental X ray pictures, that is the subdivision of two angles. Consequently the central ray from the target is directed at right angles to the imaginary line which subdivides the angle formed between the long axis of the casette and that of the femoral neck. The same object can be obtained by directing the ray along a line which subdivides the angle formed by two lines, one at right angles to the casette and the

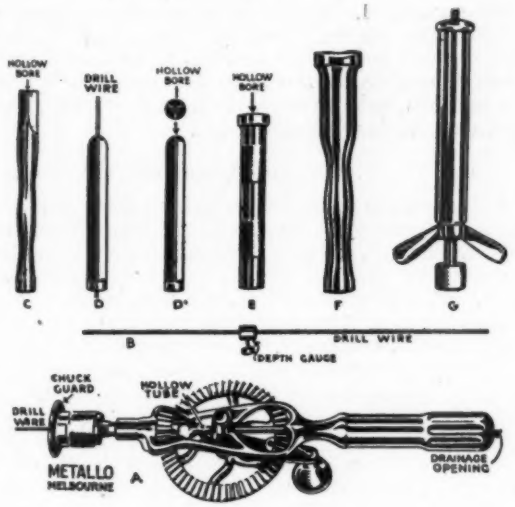


FIGURE XXV.

Instrumentarium for the operation.

A. Simple drill.
B. Drill wire and depth gauge for measuring required length of nail.
C. Nail starter (Smith-Petersen).
D. and D¹. Canaliculized Smith-Petersen nail.
E. Canalized punch (Smith-Petersen).
F. Bone impactor (Smith-Petersen).
G. Nail extractor.

The drill is a very simple one, allowing the wire to fit into a tube running up the whole length of the drill. Thereby 12·5 centimetres (five inches) of wire, or less, at a time, are allowed to project from the chuck. If collapsible guides are used to prevent "whipping" of the wire, the guide wire behind the neck of the femur (inserted under fluoroscopic control) cannot be easily "sighted". The drill should be rotated slowly, also, to prevent bending of the wire. Note the expanded plate at the end of the chuck to prevent the operator's fingers, if not sterile, from slipping off on to the wire itself when releasing more wire. The whole 12·5 centimetres length of wire can be rotated without bending, if it is supported by the artery forceps (as in Figure XX) held by an assistant. An electric drill is very superior.

other at right angles to the long axis of the neck and head (Figure II). This central ray is directed towards the neck about mid-way between the head and the great trochanter. A line drawn between the head (see above) and another point about three fingers' breadth distal to the top of the great trochanter indicates the long axis of the neck and head.

A disadvantage is that this method cannot be used with an ordinary Bucky table, and thus very clear pictures are not obtained. With the fixed Lysholm grid, more especially with the new moving Lysholm grid, however, this difficulty may be partly overcome.

4. *Curved Casette in the Perineum* (Figure VI). With our technique this method has not been used, but it can be adapted for intraarticular osteosynthesis by those not having shock-proof X ray units.

X Ray Arrangements for Making Frontal and Lateral Pictures on the Orthopædic Table.

A Philips "Metalix" mobile shock-proof unit, having an output of 80 kilovolts and 30 milliampères of current, is used. The frontal pictures are taken in 0·3 second and the lateral in 0·6 second. The screening is carried out at 60 to 70 kilovolts and with four milliampères of current. No burning of the skin has ever occurred.

The whole unit is pushed in between the slightly abducted legs. The wooden box used as a body support has no perineal bar to obstruct the X rays, nor to prevent the tube from being swung under the patient from buttock to buttock. This is well seen in Figure XVIII.

Frontal X ray pictures are made with the casette lying on the front of the hip and the tube below. It is very important that the small round opening of the "Metalix" tube which indicates the target be placed immediately under the neck of the femur, otherwise there will be errors of projection. The operator should adjust this himself, as he can feel the posterior aspect of the neck of the femur very easily when the latter is internally rotated.

The lateral pictures are made with the target at the same horizontal level as the great trochanter, which the operator can easily feel. It is very important to see that the X ray tube is pushed firmly into the

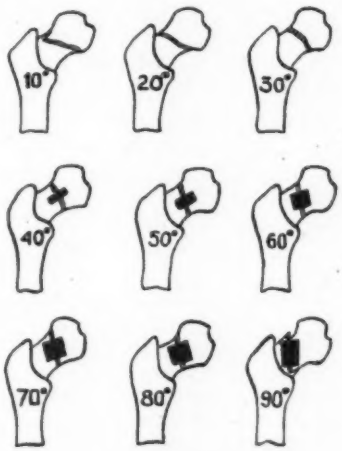


FIGURE XXVI.

Drawings to show the prejudicial effect on bone healing of a vertical as against a horizontal fracture line of the femoral neck. When the obliquity of the fracture is more than 30°, a shearing between the fractured surfaces becomes more likely. This tendency is diagrammatically represented by the black rectangle which is shown to become increasingly larger as the fracture line becomes more vertical. Patients with a vertical fracture should not use weight bearing until later than in the horizontal type, the best representative of which is the abduction fracture as in Figure XXVII. (From Pauwels, at the Congress of the German Orthopædic Association in October, 1934.)

perineum in contact with the *symphysis pubis*. Otherwise the head of the femur will not be seen, and great distorsion follows. It would really be better to have the tube some distance away but situated farther from the mid-line; this, however,

is impossible because the other thigh, as a result of the small amount of abduction, prevents the tube from being so placed. In order that the tube can be placed so close to the perineum, it is obviously necessary to see that the patient is brought well down on the body box. Thus the perineum actually hangs a little distance over the support upon which the sacrum lies. The direction of the target should be at right angles to the line which subdivides the long axis of the neck and the casette. Perfect X ray pictures are not obtained, but they satisfactorily control the reduction and guide wires.

Two shock-proof tubes and generators would be ideal, but very expensive. Actually very little time is lost in adjusting the position of the tube from the frontal to that for the lateral views.

The minimal number of X ray examinations in the series may be set out as follows:

1. Preliminary diagnostic frontal and lateral views. The lateral view is not essential, and is made by method 2 or 3.

2. Frontal and lateral views after reduction of the deformity on the orthopædic extension table and after a wire has been pushed behind the neck of the femur under fluoroscopic examination (Figures XVIII and XXI). Lately I have omitted the second X ray examination in the series because I have become more certain of the reduction. Also I can now rely on the wire behind the neck being correctly placed under fluoroscopic examination. Fluoroscopic examination of bones apparently requires some practice.

3. Frontal and lateral views when guide wires have been introduced into the femoral neck and head.

4. After insertion of the nail the patient is removed to the ward trolly. Frontal and lateral views are then made, the latter according to method 1, that is, in the lithotomy position and using a Lysholm grid.

5. Every six weeks for the first three months frontal and lateral pictures on the Bucky table are made in order to be sure that no redislocation of the fragments has occurred. This is a danger that must be watched for. After three months, often before, evidence of union should be detected, especially in the lateral view. In this view subperiosteal callus may be evident on the anterior aspect of the neck of the trochanteric fragment after six weeks. Nevertheless most of the union is by internal callus. Although there may be no radio-translucent line indicating non-union between the two fragments, nevertheless strong ossification of the callus cannot be assumed until the bone patterns of the two fragments interlace. Another appearance, seen when firm bone healing has occurred, is a dense band at right angles to the long axis of the bone at the site of the old fracture. On the other hand, the presence of a translucent line, although the bone on the proximal and distal side of this is dense (thereby indicating bony reaction and tendency to heal), does not necessarily indicate non-union. The last mentioned appearance may remain for months. No doubt this union is firm, but not sufficient to allow removal of a nail. Consequently the nail in any case should not be removed under about a year, because cases have been reported in which, despite apparent bone union, the fragments have become separated when the nail has been removed and weight bearing on the now unsplinted neck has been permitted. This tardiness of union, no doubt, has been responsible for failures after treatment by the Whitman method. In conclusion, it is important to reiterate that the nail acts as a splint, not only in the pre-callus and callus stages, but later during the strengthening or true ossification of the bone callus. Furthermore, accumulation of experience since the introduction of the Smith-Petersen nail has shown that the nail may loosen and fail to act as a splint in a certain proportion of cases. This can occur whether the nail has been introduced either by extraarticular or intraarticular osteosynthesis.

Preliminary Treatment.

It has been urged that operation as early as possible is very desirable. Otherwise fibrous union may rapidly develop, thereby delaying or even preventing the onset of bone callus, when the nail is introduced later. It is difficult to know for certain whether this is correct, and, if correct, how long after the injury fibrous union can occur. In this regard I performed a *post mortem* examination six weeks after an injury, but no fibrous tissue between the fragments was noted. The patient had developed broncho-pneumonia soon after admission to hospital. Consequently no operation was performed, but the fracture was treated by suspension of the limb on a Braun splint with traction. By this treatment the fracture was reduced and moderate immobility was obtained, but of course rotation between the fragment could not be prevented.

In those cases in which fibrous tissue has been found at operation or after death occurring fairly early, it is easy to understand that it has been mistaken for capsule, orbicular ligament or synovial membrane, which in some cases, especially when walking has been attempted after the injury, is stretched and torn. It is for this reason that in all cases after the diagnostic X ray examination the limb is immediately suspended on a Braun splint with a traction of 4·5 kilograms (10 pounds) acting on a Kirschner wire or Steinmann pin through the upper end of the tibia. More than 3·6 to 4·5 kilograms (8 to 10 pounds) should not be used, otherwise the capsule and the muscles, especially the adductors, will be stretched, favouring the development of over-traction later when the patient is on the orthopædic table and then constituting a difficulty in reduction. If strapping extension is used, general or local anæsthesia (the latter produced by injection of the hip joint) would generally be necessary, and furthermore the operated skin area could receive no pre-operative sterilization. (The latter, however, is not an important point.) Therefore skeletal traction, introduced under local analgesia, is used in preference. Besides, it has the great advantage that external rotation of the leg with rolling outwards of the neck of the femur can be controlled by suspending the outer end of the stirrup to the overhead beam by a weight of 0·9 to 1·8 kilograms (two to four pounds). After traction has been applied

ILLUSTRATIONS TO THE ARTICLE BY Dr. THOMAS KING.

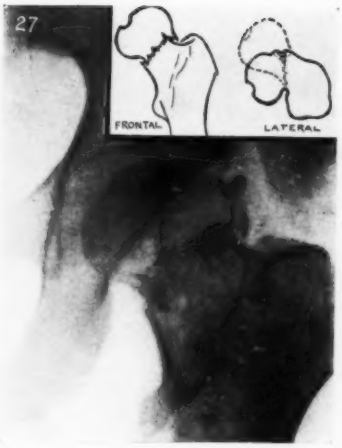


Figure XXVII.

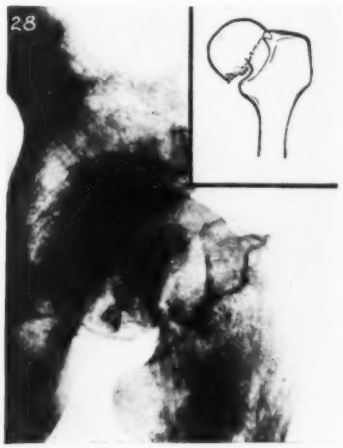
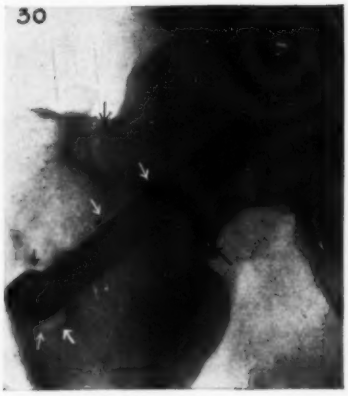


Figure XXVIII.

Figure XXIX.



F.gure XXX.

Figure XXXI.

Figure XXXII.

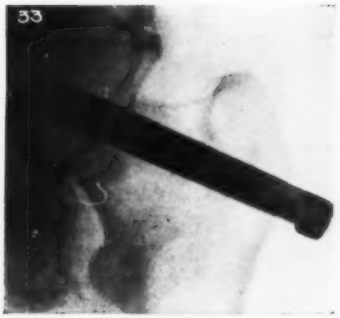


Figure XXXIII.

Figure XXXIV.

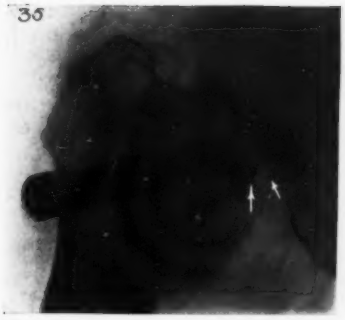


Figure XXXV.

ILLUSTRATIONS TO THE ARTICLE BY DR. THOMAS KING.

FIGURE XXXVI.

FIGURE XXXVII.

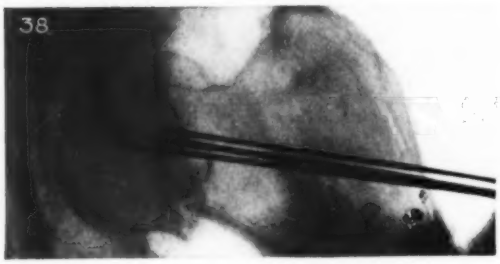


FIGURE XXXVIII.

FIGURE XXXIX.

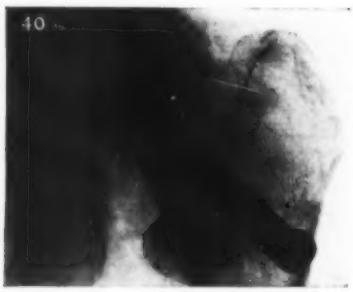


FIGURE XL.

FIGURE XLI.

FIGURE XLII.

FIGURE XLIII.

ILLUSTRATIONS TO THE ARTICLE BY DR. THOMAS KING.

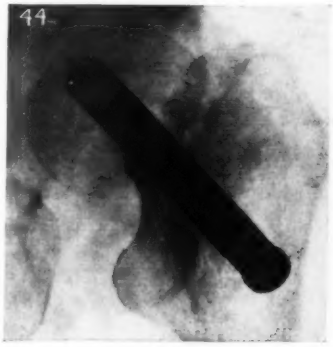


FIGURE XLIV.

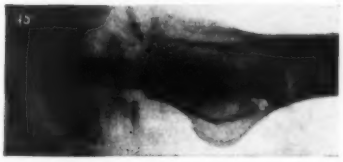


FIGURE XLV.

FIGURE XLVI

FIGURE XLVII.

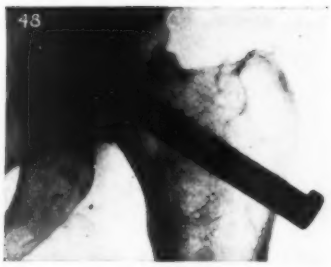


FIGURE XLVIII.

FIGURE XLIX.

FIGURE L.

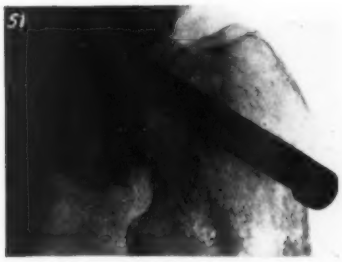


FIGURE LI.

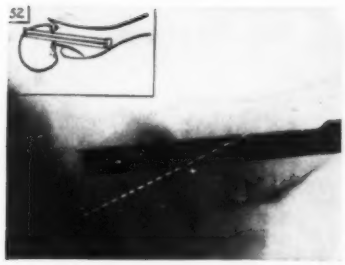


FIGURE LII.

ILLUSTRATIONS TO THE ARTICLE BY Dr. THOMAS KING.

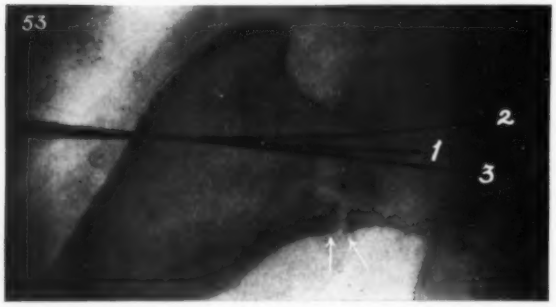


FIGURE LIII.

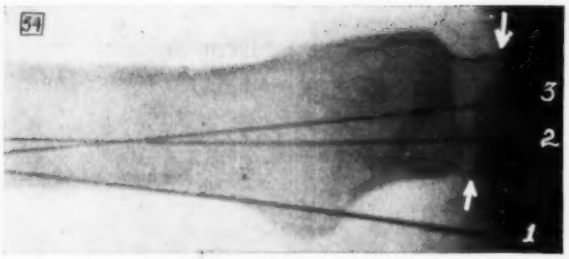


FIGURE LIV.

FIGURE LV.

FIGURE LVI.

FIGURE LVII.

FIGURE LVIII.

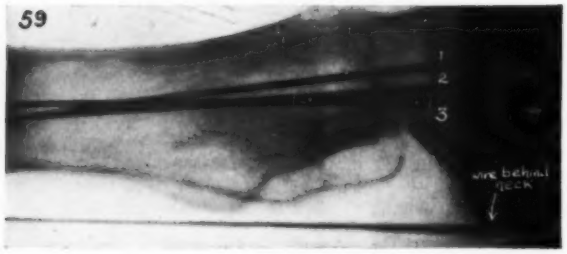


FIGURE LIX.

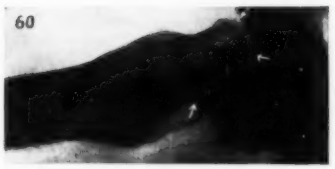


FIGURE LX.

pain almost immediately disappears. The patient can cough, use the other limbs, and move the trunk with little or no discomfort. It will be admitted that with such preliminary splinting the intervention of torn capsule or synovial membrane is unlikely to occur because they are stretched, and the deformity is reduced. The development of fibrous union is a remote possibility for some time. Before it can occur the patient has time to recuperate and be fit for any operative procedure.

Figures XXXV and L show firm bone union on the posterior and upper aspect of the femoral neck, and indeed the patient was walking well at this stage, but no union is present on the anterior and lower aspects. The patient walked on the limb after receiving the injury, and this may account for torn capsule becoming insinuated between the fractured surfaces, although the fracture was well reduced. If this is so, then we may assume that union can occur, even though there is some fibrous tissue intervening. Schmorl showed this in specimens. On the other hand it is more probable that union in the above case may be retarded merely by the blood supply being deficient on the anterior and lower aspect of the neck, the situation of the dense cortical bone, and the rather closer cancellous bone in the site of the *calcar femoralis*. Although it has been assumed that the nutrition of the head is almost solely dependent upon the blood vessels within the neck, it is difficult to explain why "aseptic necrosis" of the head has followed injuries such as traumatic dislocation (without any fracture). The *ligamentum teres* and retinacular fibres would certainly be ruptured. On the other hand both these structures are sometimes absent and tend to decrease in size after childhood. Since the *ligamentum teres* is a vestigial structure, very small blood vessels are unlikely to be of any significant nutrient value to the head.

Conclusion. In all cases for the first ten days, and in others when the general condition of the patient (bronchopneumonia, for example) contra-indicates any operative treatment for the time being, the limb is suspended on a Braun splint. Shortening is corrected by skeletal traction by a pin or wire through the upper end of the tibia. The external rotation of the limb results in an important anterior displacement (seen only in the lateral X ray examination). The limb is brought into internal rotation by tying up the outer end of the pin or wire to an overhead support. The splint is placed in the abducted position, and the patient prevents tilting of the pelvis by resting the "good" foot against a foot-rest. The patient is instructed to keep this limb in abduction. As soon as the general condition improves, operation is carried out in all cases. Patients with subcapital fracture of the neck of the femur admitted into our ward are rarely operated upon before ten days after the injury. It is well known that after injuries and operations on bones pulmonary embolism (producing "post-operative pneumonia") is a complication that is not uncommon, especially in the aged. Since the embolism seems to be due to the passage of a thrombus from the injured area, it seems prudent in the case of fracture to delay operative procedures until local thromboses in the medullary and cancellous vessels have become partially organized, that is after ten days. Some of our patients on admission to hospital were very shocked, others were suffering from pulmonary or other complaints which rendered immediate operation inadvisable if it did not contra-indicate it. Four of these patients died, but every one of the others (except a patient of ninety-four years whom I declined to operate upon) who regained health during nursing treatment, was eventually operated upon after about three weeks. This delay in operation is an important point if the mortality rate is to be low. The need for this delay, owing to the poor condition of many of my patients when first seen, has decided me in this view. Some of those who recovered sufficiently to permit extraarticular osteosynthesis would hardly, I think, have withstood arthrotomy, which some surgeons do not hesitate to perform very early because the nursing of the patient thereafter is considered easier. A low mortality rate is claimed for the original Smith-Petersen intraarticular osteosynthesis, but most surgeons would perform arthrotomy only in good surgical risks. Therefore the cases for the original Smith-Petersen operation are probably carefully selected, whereas our cases are not carefully selected at all. I strongly deprecate immediate operation.

Anæsthesia or Analgesia.

Since the time occupied by the painful procedures is relatively short, spinal or local analgesia is more rational than prolonged or intermittent general anæsthesia, which is often contraindicated in dealing with old people on account of chronic pulmonary complaints. In most cases spinal analgesia has been used. "Decicain" ("Pantocain"), 2·5 cubic centimetres, has been used almost exclusively until recently because a prolonged analgesia resulted (two to three hours). I have now abandoned spinal in favour of local analgesia because it adds a further degree of safety to the whole procedure. I have followed Dr. Leo Doyle's advice in the following instructions:

> For five days prior to the operation 1·0 gramme (fifteen grains) of sodium bromide is administered by mouth three times a day. At 8 p.m. the night before the operation 0·6 gramme (ten grains) of barbitone is given. At 6.30 a.m. next morning 0·43 milligramme (one-one hundred and fiftieth of a grain) of hyoscine is administered hypodermically. At 8.30 a.m. 0·15 gramme (one-quarter of a grain) of morphine is injected. At 9 a.m. the patient is brought into the theatre with the limb still under traction on the Braun splint. With the patient still on the trolly 20 cubic centimetres of 0·05% "Percaine" (because it provides prolonged analgesia) is injected into the hip joint by the route just proximal to the tip of the great trochanter, which is easier than passing the needle in front or behind. Forty cubic centimetres of "Percaine" are injected over the lateral aspect of the upper end of the femur and behind the femoral neck. The Kirschner wire or pin is now removed from the tibia and after a few minutes the patient is removed on to the orthopædic table.

The above technique has been extremely satisfactory and is strongly recommended.

Reduction of the Deformity.

A very exact adjustment of the fractured surfaces to one another is required because the vascularity and nutrition of the femoral head depend almost

entirely upon the arterial, venous and lymphatic vessels reaching it from the neck. Consequently the fracture heals almost entirely by the formation of internal callus. The vascularity of the proximal end of the femur may be realized from observing the numerous foramina in the neck of a dried bone. Furthermore the neck notoriously and rapidly becomes decalcified and absorbed in ununited fractures, but the calcium content of the head remains unchanged for a long time because it is now avascular. The latter appearance is characteristic of an old fracture which is ununited, and looks relatively denser than the living neck, which is absorbed up to the cervico-trochanteric juncture. Even stainless nails which are practically unaffected by the tissues, actually show slight effects of erosion in the neighbourhood of the junction of the neck with the trochanteric part of the proximal end of the femur. Chromium plated nails should never be used, because the presence of three metals sets up electrical and chemical disturbances. The chromium plate is deposited on a copper covering. This affects the bone far more rapidly. The vascularity of the parts in this special situation seems to aid these changes. In this connexion Kellogg Speed showed a series of illustrations of Phemister in which a nail had gradually disintegrated in the neck and head of the femur, but especially the end in the head. Non-union resulted, and he suggested that the ununited head was vascularized despite non-union, because otherwise the end of the metal in the head could hardly have been so eroded. However, since the nail was bathed in tissue fluids, electrolytic activity could occur, even though the head was devascularized. The nail used could not have been constructed of stainless steel.

Since accurate direction of the nail and firm fixation of the femoral head cannot be anticipated unless the fractured surfaces are reasonably accurately adjusted, a consideration of the reduction manœuvres has been included. Such directions will be superfluous to and are not intended for the experienced. Nevertheless they have been included because the criticism often has been made against this method that the reduction of the deformity compares very unfavourably with the open method of reduction. This will naturally depend upon the surgeon. Fortunately the deformity can in most cases be corrected. As a rule there is no difficulty, and treatment is especially easy when preliminary reduction has been obtained and when the correction has been maintained for ten days to three weeks before the operation. This is probably due to the fact that the fracture is surrounded by a strong capsule which is stretched on the traction splint. When the capsule is torn through on its anterior aspect, the preliminary stretching can still be effective in adjusting the fragments. In that well known type of fracture in which there is a "spike" of bone attached to the capital or cervical fragment, reduction has not been any more difficult unless over-traction or excessive abduction has been used.

The stages in the correction of the deformity are: (i) Traction to overcome the shortening, (ii) slight abduction (not essential), (iii) internal rotation to correct the external rotation. They mainly follow the well known directions of Whitman. It is important that each stage is carried out according to the order set out above, and not one before the other.

Traction to Overcome the Shortening.

All sheets and clothes are removed from the umbilicus to the toes, otherwise disarrayed sheets *et cetera* cover up the body support and leg extension pieces, and tend to obscure the assistants' view when the patient is lifted on to the padded box (see Figure XVI) and then care cannot be taken to see that the trunk lies symmetrically thereon. The box has no perineal bar because it would obstruct the free movement of the X ray tube underneath the hip joint. Two well padded straps are used for the counter traction in the perineum. The limbs are attached by the feet to the sole plates of the leg extension pieces by leather gaiters which are laced over the ankle, and which had previously been neatly wrapped and padded with wool and bandages. This leather anklet, by its side straps, prevents the heel pulling away from the sole plate when any traction is used. The side straps should be sewn to the anklet by the saddler, so that they are just in front of the tendon of Achilles. Further bandages over the leather anklet insure that when the sole plate is internally rotated the foot will also rotate with it, and not independently of it. Therefore after every turn of the bandage around the foot two complete turns should be taken around the ankle. Johansson has advised as an extra precaution that the whole foot and ankle should be wrapped in plaster bandages. If the above bandaging details are not respected, we may find that later on during the course of the proceedings the foot has gradually sunk back into a position midway between internal and external rotation (Figure LII). I have recently added to the sole plate simple side attachments which prevent the foot rotating independently of the plate.[1] In no circumstances must any abduction be present during this stage. The limbs should be almost parallel. If abduction is performed prior to traction, it may be difficult to overcome the shortening. All parts of the patient except the actual area of operation are now covered with heated blankets.

When there is minimal displacement with little shortening we must be more careful than ever in using the orthopædic extension apparatus because the powerful and unsympathetic pull by the screw traction may over-extend the limb. In any case the shortening is never very much (especially if the limb has been immobilized for ten days or more under traction on a splint), because under spinal or local analgesia the pelvi-trochanteric muscles are relaxed. Furthermore these muscles are mainly external rotators, rather than tending to cause any shortening. External rotation ("eversion") is the most important and difficult deformity to manage because it is associated with a forward displacement of the neck which in many cases projects anteriorly through a hole in the joint capsule. Muscle action

[1] All instruments and apparatus used are obtainable from "Metallo" Technical Manufacturing Company, Kooyong Road, Caulfield, Melbourne.

does not appear to be greatly responsible for any of the displacements (except adduction), which are not very pronounced as a rule compared with those of other fractures. If muscles were responsible, Leadbetter's palm test of a good reduction could not be carried out. In this now well known test, after the deformity is thought to have been dealt with, the limb is fully abducted and extended, with no traction. The heel of the foot on the affected side is rested in the operator's palm. If no shortening develops and the foot does not rotate externally, the fracture is said to be properly reduced. Both the special manœuvres and test are sound in principle and practice. They are more suited for application when an orthopædic mechanical traction apparatus is not used.

The operator or an experienced assistant now grasps the ankle of the injured member and externally rotates the limb, but with no abduction. At the same time he exercises reasonably powerful traction on the limb. So relaxed are the muscles by the spinal or local analgesia that even strong manual traction may over-extend the fragments, especially if the preliminary traction on the splint has been too great. The object of this external rotation is further to exaggerate this deformity and to insure that there can be no interdigitation of the denticulated surfaces of the two fragments. These could then prevent an exact correction of the shortening, and therefore an inexact coadaptation of the surfaces would result. Furthermore in some cases the neck belonging to the trochanteric fragment lies behind the head (Figure IX) instead of in front of it, as is usually the case. Since the final manœuvre of reduction is strong internal rotation, which is made on the assumption that the fractured surface of the trochanteric fragment is looking forwards, it is important in order to be assured of this to rotate the limb externally at this stage. A clinical sign which indicates this possibility of the neck lying behind the head is the slightness of the characteristic external rotatory deformity. This is so-called "eversion". Although in recent cases it is a rarity for the lower fragment to lie behind the head, this state of affairs is the rule in ununited fractures of old standing when walking has been carried out. Then the neck belonging to the distal fragment ascends and lies on the ilium.

If this traction is exerted after abduction of the limb and not before, the stretched adductor muscles may tend to jamb the neck tighter against the upper margin of the femoral head and prejudice the descent of the neck belonging to the distal fragment [Figure XIII (E)]. Even if this longitudinal traction is performed with the limbs in the neutral position, that is, neither in adduction nor in abduction, the trochanteric fragment may hitch upon the upper part of the head of the femur. On the other hand some surgeons have considered this an advantage, because the upper fragment may be abducted, and by drawing the distal fragment downward the head is rotated downwards also from the abducted position. However, with abduction and internal rotation of the distal fragment, the freely movable head tends later to become adjusted to it, especially when the capsule is intact on all sides. Therefore in order to avoid any manipulations of the distal fragment disturbing the proximal and to insure that during all the stages of reduction there will be a "gap" between the fragments, longitudinal traction is combined with lateral traction. This is obtained by an assistant pulling laterally and at right angles to the longitudinal traction, with a loop of towel around the adductor region of the thigh (Figure XVI). This method has been stressed by Robineau and Contremoulins, Delbet, and others. It has a further recommendation that the resultant of the two forces is a direct pull in the long axis of the neck (inset Figure XVI). The operator now transfers the traction of the ankle one hand at a time to an assistant and with a tape measure himself compares the measurements of the two limbs from the anterior superior iliac spines to the upper borders of the patellæ. Actually it is much simpler, and with practice a very accurate procedure, to determine shortening and backward displacement of the trochanter by placing the thumb of either hand upon each anterior superior iliac spine and the index finger of the corresponding hand on the tip of each great trochanter. This is a method on which I place great reliance. It has an added advantage that, whereas the length of the whole femur normally can vary as much as a half inch or more on the two sides, the neck length varies very slightly. Therefore the tape measure can be less accurate in determining correction of the shortening.

Abduction.

Abduction should only be very moderate. There should be only about 60 to 75 centimetres (24 to 30 inches) between the ankles, since abduction has no effect whatever in "reducing the fracture", but acts by stretching the adductor muscles, which then tend to impact the fractured surfaces. Another function of abduction is to restore the normal neck-shaft angle of about 130°, but this restoration can occur without it. Traction *plus* moderate abduction has an influence also in causing a separation of the fractured surfaces by exercising the extension in the long axis of the neck (see inset Figure XIII), but this effect is obtained more certainly by the lateral pull with a towel around the thigh. According to the Delbet technique of treating these fractures, the outward traction on the femoral neck has been stressed for years, but Robineau and Contremoulins seem to have first described it. It is obtained by a pelvic support which, by an adjustable clamp, thrusts the neck of the femur outwards. Fitting this apparatus is his "*canon*" for guiding the screw, which has apparently inspired Johansson's aiming apparatus for drilling Kirschner wires into the femoral head. Our main reason for abduction is to allow sufficient room between the thighs for the X ray tube when taking the lateral X ray pictures. Otherwise, with this additional lateral pull, abduction can be dispensed with altogether. Thus Delbet, Tavernier and other French surgeons recommended lateral and longitudinal traction instead of abduction for an extraarticular screwing of the fragments. Thereafter they operate with both the patient's legs bandaged together. External rotation is prevented by bandaging the two feet or tying the big toes together.

If the limb is abducted so that there is a greater distance between the ankles than about 75 centimetres (30 inches), there is a danger that the upper edge of the neck of the trochanteric fragment may tend to descend below the head, or at least produce a gap between the lower edges of the fractured surfaces [Figure XIII (B) and (D), also Figure LIII]. Both are specially liable to happen with the limbs stretched out on an orthopædic table. It will be appreciated that under such a fixed mechanical traction arrangement, when the limbs are abducted an unyielding force is acting. No "take up" by shortening of muscles is possible as occurs when manual methods are used. When excessive abduction has been preceded by over-traction with a mechanical pull by the tightening of a screw, then the trochanteric fragment descends below the head [Figure XIII (A) and (B)]. The neck may become entangled in capsule or in synovial membrane, or even the psoas tendon has been observed to intervene. It is difficult then to obtain a good reduction. Such a mistake is especially harmful if a long "spike" from the *calcar femoralis* has, as a result, "buttonholed" the lower part of the synovial sac and capsule (especially thin on the lower and posterior aspect at any time). Then the obvious manœuvre shown in Figure XIII (C). must be used, that is, disengagement of this malposition with an upward and outward pull on the loop of bandage around the adductor region. These effects have not been stressed in the literature of the Whitman method of reduction; and immobilization of the injured limb in the "fullest abduction" is due no doubt to the fact that manual and not screw traction has usually been used. Nevertheless it has happened twice to me, and then the operation was performed in three hours. M. Boppe recently referred to it. With manual traction, which I use exclusively, over-extension is unlikely. The orthopædic apparatus is used only to maintain reduction. In the Whitman "abduction method" the exaggerated abduction certainly tends to jamb the fractured surfaces together, owing to shortening of the adductor muscle, but it appears to be concerned mainly with preventing the shortening during the immobilization in the cast. This is obtained when the upper part of the neck and tip of the great trochanter and muscle insertions thereto are in proximity to the upper margin of the acetabular rim. This exaggerated abduction has often been criticized because, unless the head rotates also into the abducted position, an imperfect reduction results. For example, the fractured surfaces are separated on the lower aspect of the neck or the head is imperfectly adjusted to the distal fragment so that *coxa valga* results, but this is really no objection so long as coadaptation of the fractured surfaces is sufficiently accurate so that bony union results. With the unremitting traction on an orthopædic table this separation in the lowest aspect of the neck can certainly occur (see Figures LIII and LVII), but it is easily "taken up" later when we slacken off the extension before using the impacting instrument.

Internal Rotation.

This should be the last manœuvre. Inward rotation of the distal or trochanteric fragment serves two important purposes. In the first place the fractured surfaces are brought into contact. Prior to this they may be almost at right angles to one another, owing to the outward rotation of the neck attached to the distal fragment (Figure IX). In the second place this exaggerated position must be maintained in order to prevent the deformity recurring until the nail is inserted. Therefore the forward inclination of the head and neck in regard to the horizontal plane is effected, which is important when introducing the guide wire.

In a number of cases an irreproachable adjustment of the fractured surfaces to each other has not been obtained until the following manœuvres were performed. Two assistants are necessary. One controls the internal rotation by the clamps of the foot piece. The other pulls laterally with the sling around the adductor region. Thereby a gap is formed between the fragments. If there is no lateral pull, instead of this gap the fractured surfaces at some point or other must be in contact. Therefore it follows that when the distal fragment is internally rotated the head may be rotated backwards, as shown in Figures XIV and XV. Non-union is then very likely to be a consequence because of the poor apposition, although the antero-posterior X ray picture alone may show an apparently perfect reduction. Further, it would be difficult to impale the head with a nail under such conditions.

Now the limb is strongly internally rotated by the assistant. At the same time the surgeon presses backwards with his thumb on the anterior aspect of the neck of the trochanteric fragment. With his other hand behind the great trochanter the neck is briskly and vigorously swung upwards and inwards. This manœuvre is combined with a forward thrust on the dorsum of the great trochanter overcoming any backward sagging of the proximal end of the femur. The assistant and the operator controlling the proximal end of the femur should perform these manœuvres exactly together. A "click" is felt when the internal rotation is carried out and the thumb is pressed strongly on the distal fragment, despite the lateral pull which is seldom sufficient to create such a space between the fractured surfaces that there is not some slight contact between them (see Figures XIV and XV). It often can be heard by the assistants and others near by, even in fat patients. I consider the manipulation of the distal fragment by the thumb very important, because I have always felt the grating as the fragments became adjusted. It is unlikely that a very strong movement of internal rotation would force the fractured surface of the neck belonging to the trochanteric fragment behind the head. Nevertheless I noticed this occurrence in a cadaver experiment. Notwithstanding, I formed the view that, when the posterior part of the capsule and pelvitrochanteric muscles were stretched by a combination of internal rotation and longitudinal traction, as on the orthopædic table, this would hardly develop. Furthermore, in the above cadaver observation when the internal rotation was reduced slightly from its exaggerated degree the fragments readjusted themselves. Therefore after the above vigorous manœuvres have been

carried out the forced internal rotation is lessened and thereafter maintained with the patella looking inwards at about 25° by clamping the foot plate. This is really not very much, because a certain amount of rotation is taking place at the knee, ankle and tarsal joints. It will also be noted that the more the limbs are abducted, the less the degree of internal rotation that can be obtained. This appears to be due to stretching the adductor muscles with abduction. With a good reduction and maintenance of the internal rotation the retrotrochanteric fossa in the buttock again becomes well marked. The proximal end of the femur, especially the great trochanter, stands out well.

If abduction is performed after and not before internal rotation has been carried out, then disarrangement of the fragments can occur.

The Drilling of the Guide Wire into the Bone.

For at least twenty minutes prior to this stage the operator wears dark goggles in order to accommodate the eyes to darkness. Then it is easier to see plainly the outline of the bones in the cryptoscope. The preliminary "eye preparation" is not absolutely essential, although it is a wise safeguard, because with the new Levy-West-Patterson fluoroscopic screen the picture seen is so brilliant.

The operator, who continues wearing dark goggles, washes up whilst the nurse paints the skin with iodine and drapes the skin around the trochanteric region with a sterile towel having a small hole in it. A sterilized lead rubber screen has previously been placed over this area and the front of the hip joint. There is an opening in front to permit of the X rays passing through to the fluoroscopic screen, but there is only a small slit at the side, through which the Kirschner wire can be thrust (not shown in Figure XVIII). Thereby the surgeon who frequently uses this method is adequately protected from harm by the X rays. Whilst it is not absolutely essential at this stage for the surgeon to wear sterile gloves and to have sterile towels draped around the area, this is to be strongly recommended because he cannot see very clearly owing to the dark goggles, and may thus touch a non-sterile area with the sharp end of the wire without knowing it. The tip of the trochanter is palpated. Then the wire is thrust behind and as close to the posterior surface of the femur as possible and at least three fingers' breadth distal to the tip of the great trochanter. The wire should pass in behind the bone in the direction of the head, the apex of which is just below the mid-point of Poupart's ligament. Actually, even in fat subjects, it is possible to determine by palpation the anterior part of the acetabulum and head of the bone and also the outline of the neck, especially with practice. The point of the wire first of all slides against the prominent posterior intertrochanteric ridge.

Now, having previously slipped off the goggles, the operator transfers his attention to the operating fluoroscope (cryptoscope) which an assistant adjusts for him. During the brief interval between looking through the fluoroscope and removing the goggles the eyes should be kept closed to exclude light from affecting the dark accommodation. If the fluoroscopic box does not fit tightly around the eyes, a black sheet should be thrown over the head. The shaft, trochanteric region and neck of the femur can always be plainly seen, even in a sixteen stone patient. The head is not seen so distinctly, but the proximal and distal edges of the acetabulum, like a cup, can always be seen. Consequently the head is clearly indicated. The point of the wire is plainly seen. If necessary it is now partly withdrawn and precisely directed so that it lies between the proximal and distal borders of the neck parallel with the long axis of the neck. The wire should be nearer the lower border of the neck. The point should always be kept close to the back of the bone. (On account of the trochanteric ridge behind, a wire on the front of the neck would indicate the angle of torsion more accurately than when the wire lies behind the neck; but an anterior wire might injure the femoral vessels.) When this has been satisfactorily accomplished under direct vision, the point of the wire is firmly anchored by thrusting it strongly so that the point penetrates slightly either the expanded head (if soft and atrophic), the acetabular rim, or actually enters the cleft between the head and the cotyloid ligament (*labrum glenoidale*) which fits around the rim of the acetabulum.

The following mistakes can occur. (These remarks assume that the patient is lying horizontally and supine):

1. If a wire finer than 1·5 millimetres (one-sixteenth inch) is used it cannot be directed properly. Bending and kinking may occur. The operator thus loses his sense of direction.

2. If the point of the wire has been thrust through the skin in front of the posterior border of the proximal end of the femur, instead of just behind the neck, it must strike the lateral aspect of the femur. It would be wrong now to withdraw the wire slightly and then to negotiate its pointed end behind the femoral neck, for if this were done the wire would be directed on to the dorsal surface of the ilium. Thereby it could in no way indicate the angle of torsion of the neck which it would do if lying along the back of the neck. Furthermore, the point of the wire lying against the ilium is very insecurely fixed, contrary to what happens when the point is thrust through the joint capsule on to the expanded head or into the fibrocartilaginous ring which constitutes the cotyloid ligament, encircling the acetabular rim. Therefore the wire should be withdrawn altogether and thrust through a new skin puncture, now situated more correctly farther dorsally. If the skin is loose and can be pulled backwards, it is not always necessary to make a new puncture, but the former course is safer. A little practice on the cadaver, which is easily obtained because the body is not mutilated thereby, will demonstrate that the wire should slip inwards smoothly without any bending between two points, the operator's hand grasping the wire and the dorsal border of the proximal end of the femur.

3. If the wire is inserted through the skin, not in the same horizontal plane as the posterior border of the femur, but some distance behind it, then the wire does not correctly indicate the torsion angle.

The fluoroscopic examination is now concluded. Frontal and lateral X ray pictures are now made to show the reduction of the fractured fragments and position of the wire.

The X ray picture taken in the frontal plane (the X ray tube is behind the buttock as for the fluoroscopic examination in Figure XVIII and the casette lies on the front of the hip) indicates the following: (i) Whether reduction is satisfactory, mainly in regard to shortening and adduction of the lower fragment (Figure XXXVI). (ii) Whether the wire is placed parallel with the long axis of the neck, approximately in the lower third of the neck. (iii) The distance the point of the wire has travelled towards the fovea (or apex of head) should be noted. This is important in determining which wire is which in frontal views later, because when two or three wires are in the bone at different depths each can be separately recognized.

The lateral view shows: (i) the reduction of the deformity. The head ideally should be placed exactly on the neck (Figure XXXVII), so that the diameter of the head is at right angles to the long axis of the neck and not as in Figure LII. Nevertheless it is a normal state of affairs for the head to be retroverted on the neck; occasionally in such cases a wire drilled mid-way between the front and back surfaces of the neck would pass through the front of the head [Figure VII (A)]. (ii) The angle formed between the long axis of the neck and the wire lying behind the neck. Sometimes the wire and the long axis of the neck are parallel. Thereby the problem of the torsion angle is solved. If the wire is absolutely parallel with the long axis of the neck, then the second guide wire must be drilled into bone exactly parallel with the first wire, but usually an allowance has to be made because the long axis of the neck looks forward more than the line of the wire behind the neck.

Finally the length of wire projecting from the skin indicates exactly the neck-shaft or collo-diaphyseal angle, which is about 130°, and is thus a most accurate indication to the operator for drilling the guide wire or wires into the bone at the same angle.

The drilling of the guide wire is much more easily accomplished with an electric drill because the aim is then more accurate. An Albee saw motor or a sewing machine motor fitted with a Jacobson key chuck or the special Loth's "Boros" drill (Figure XX) can be used. The collapsible guides which are fitted to all drills for introducing Kirschner wires should be discarded. They interfere with the "sighting" of the drill wire with the first guide wire lying behind the femoral neck. Johansson's drill has not this objection to the same extent, however. With the removal of the telescopic guide "whipping" of the wire during the drilling process whilst it rotates is avoided by holding the wire loosely in the blades of an artery forceps (Figure XX). When using the simple hand-drill, which permits the wire to be fed out of the drill itself (Figure XXV), we should have about 12·5 centimetres (five inches) of wire projecting from the chuck. No guide is then necessary. Thus we can see both wires with an unobstructed view. This is important if we are to introduce two or three wires into the bone within an area the size of less than a threepenny piece. This apparently rather crude method of drilling the wire or wires into the bone with no guide has been a great advance in that it permits the wires to be drilled exactly where we want them without obstruction from each other. No skin incision is made until the guide wire in the bone has been proved by frontal and lateral X ray pictures to be correctly inserted. This makes the procedure more difficult, but much safer from the point of view of maintaining asepsis. The advantages of extra-articular osteosynthesis become lost, to some extent, if a large incision is made, especially if the finger is inserted along the neck towards the head of the femur in an endeavour to find the direction of the neck in the first place and the front and back border of the proximal end of the femur in the second place. Having tested the "blind" method experimentally, with the fingers thrust along the front and posterior aspects of the femoral neck, I formed the view that a very inaccurate sense of direction was obtained. Thus the pelvi-trochanteric muscles on the dorsal aspect prevent a close palpation of the bone. Furthermore in the presence of an open wound, if more than one attempt at drilling the guide wire is necessary, it becomes difficult to maintain the asepsis during the taking of the X ray photographs. The drill wire should be made to impinge upon the lateral aspect of the femur mid-way, as a rule, between the front and back aspects of the bone. In order to obtain this spot without an incision, the drill and artery forceps, as in Figure XX, are used to push the wire first of all behind the neck, next in front of it, and finally are made to strike the bone approximately mid-way between the two borders as in Figure XIX. Sometimes we begin drilling nearer the front than the posterior surface or border of the subtrochanteric fossa of the lateral aspect of the femur. Then the wire must be drilled slightly backwards instead of parallel with the central long axis of the neck and head. The reason for this is shown in Figure VII (A), where the head of the bone is retroverted on the neck owing either to imperfect reduction, to compression of the dorsal aspect of the neck, or to a normal anatomical variation of the situation of the head.

It is now a simple matter to drill the wire into the bone so that viewed from above (the patient lying supine), which is the bird's eye view seen by the operator, the second wire is superimposed in its whole length upon the first wire. Thus the first wire is hidden from view by the second wire. The former can be seen only if it deviates from this course.

The surgeon cannot watch the wire in the other plane, and must be guided by the assistant, who directs him to raise or to lower the drill until the wire is parallel with or slightly angled more forward than the first wire lying behind the neck according to the interpretation of the first lateral X ray picture. Methods of estimating the torsion angle of the femoral neck, such as lateral X ray pictures with a water level strapped on to the thigh and another fixed to the top of the casette in order to fix the horizontal plane (Johansson), mathematical formulæ, empiric directions that the neck lies horizontally when the

thigh is internally rotated at certain angles, have been used by various authorities. Ostrowski showed that the shaft and neck of the femur often lie horizontally, if the thigh is internally rotated, so that the patella looks inwards at an angle of 20°. He emphasized that the angle was very inconstant and therefore his suggestion would not always be correct. None of the above methods can give anything more than an approximate indication. Unfortunately the femoral neck is narrower in the lateral projection than in the frontal, so that the margin of error in respect to the nail passing through the front or back surfaces of the femoral neck is much less than in regard to the nail passing through the upper or lower surfaces (Figure I). Consequently such approximate indications may sometimes lead us into errors. Recently Johansson has in a most scientific paper which commands our greatest admiration and respect, expounded a method of accurately measuring both the neck-shaft and torsion angles as well as the length of the femoral neck by a combination of X ray examination and trigonometrical calculations. None the less in their practical application errors due to the X ray projection could still creep in. As already indicated we determine approximately the angle of torsion by the wire behind the neck.

The length of the first wire (which lies behind the neck) projecting from the skin puncture is a reliable guide as to how far to drill the guide wire into the bone. The second wire should be drilled in about 1·25 centimetres (half an inch) deeper than the first wire behind the neck. A third wire is now drilled into the bone at a slightly different angle to that of the second wire in the bone to a depth about mid-way before the first and second wires (that is about six millimetres or one-quarter of an inch deeper than the first wire). This third wire, whilst usually drilled at the same neck-shaft angle as the first and second wires, is directed either more forward or backwards, as circumstances indicate, because our difficulty is mainly in regard to the forward inclination of the neck. Therefore the lateral X ray picture which shows the wire lying behind the neck should be diligently referred to. It is seldom necessary to drill in a fourth wire. A piece of sterile gauze soaked in spirit is wrapped around the wires at the point of skin penetration. Now frontal and lateral X ray pictures are taken (Figures XXXVIII and XXXIX).

Meanwhile the exposed area over the injured hip should be warmly covered with heated blankets whilst awaiting development of the exposed X ray films. The skin area is painted with equal parts of methylated spirits and ether, and no further iodization of the skin is carried out, as it may become burned. Then the surgeon scrubs his hands, puts on sterile gloves and gown, whilst the nurse arranges the sterile towel having a ten centimetre (four inch) hole in the centre of it. By this time the X ray films are ready for careful examination.

In the frontal picture the three wires should be practically parallel and sometimes actually superimposed, so that they cannot be distinguished (Figure LVII). In the latter case all are satisfactorily directed so far as the frontal plane is concerned. More often the separate wires are usually distinct and not exactly superimposed (Figure LIII). Then the three wires can be each recognized by the unequal distance for which they are drilled into the bone or by comparing the directions of the wires in the bone with the obliquity of the ends of the wires projecting from the skin. Also, the wire behind the neck is apparently thicker than the other two because it is farthest away from the casette when the picture is made with the X ray tube below the buttocks (Figure XVIII). Errors of projection arise when, in taking the postero-anterior picture, the target is not placed exactly under the neck.

In the lateral view the wire ideally should be mid-way between the "front" and "back" borders of the femoral neck and head. When, however, the head does not fit exactly on the neck, such a line is not the best [Figure VII (A) to (D)]. By comparing the various depths to which the ends of the wires have penetrated, apart from the more obvious method of recognizing each wire as the "most anterior", "middle" and "wire behind the neck", there is no doubt whatever as to which wire is which.

What appears to be the better position for the wire in the frontal view may not be so in the lateral projection and *vice versa*. Usually any of the wires in the frontal view would be satisfactory, but only one in the lateral view. It is in regard to the latter that sometimes neither wire is well placed. Then we remove only one, and that the more badly placed of the two wires in the bone. It is a bad mistake to remove both wires from the bone because the better placed of the two, though not satisfactory, indicates to the operator in what direction to drill wires again at the second attempt. If both wires in the bone had been removed because the positions were unsatisfactory, then at the second attempt the same thing might very easily happen again. When the X ray picture shows an accurate introduction, all other wires except the satisfactory wires are removed. The remaining wire can, if necessary, be drilled in a little further (about six to twelve millimetres or one-quarter to one-half an inch), but should not be drilled into the hip joint. This latter occurrence can be detected by the sensation of "give" when the wire slips into the joint. The disadvantage of this occurrence is that we cannot exactly measure the length of nail required by subtracting the length projecting out of the bone from the total length of wire (see later). Later on, after measurements have been made, it is an advantage to drill the wire into the floor of the acetabulum. The nail is then less likely to kink the wire.

Introduction of the Nail along the Guide Wire.

The skin at two points exactly proximal and distal to the guide wire is transfixed with the point of a knife, which is thrust directly on to the bone. Thereby the aponeuroses of the *tensor fasciæ femoris* and *vastus lateralis* muscles are split and the bone is exposed without any wide separation of muscle fibres by a periosteal elevator, because the vastus has a linear origin from the *linea aspera* and not from the surface of the bone. Loosening of muscles and

under cutting of skin flaps are thus avoided. The incision is only at most 6·25 centimetres (two and a half inches) in length. The part of the incision proximal to the wire is twice as long as that part of the incision distal to the wire. This is particularly necessary if there is much fat in the subcutaneous tissues, because in such a case the point of penetration of the skin by the sloping or oblique wire may be 1·25 centimetres (half an inch) or more distal to the spot where the wire actually enters the bone. As a rule no blood vessels require ligation. Retractors having two or three long sharpish prongs are invaluable with the small incision in holding back skin, subcutaneous tissues and muscles. A small area of bone only the size of a sixpenny piece is thus bared by pushing the muscle away with a gauze swab on a holder.

Measurement of the Required Length of Nail.

Another 25 centimetres (10 inches) wire, that is, the same length as the guide wire in the bone, is laid alongside the length of projecting guide wire. A small sliding collar or gauge can be fixed at any distance along the second wire to indicate on the measuring wire how far the guide wire in the bone projects beyond the outer aspect of the femur [Figure XXIV (b)]. The difference in length indicates the length of wire in the bone. This difference is usually about 8·75 to 8·1 centimetres (three and a half to three and a quarter inches). Two nails of such a length should always be at hand. No other length seems necessary, except rarely. The estimation from an X ray examination of the unbroken hip of the appropriate length of nail required in any particular case cannot be relied upon with absolute certainty, because the length of the head and neck of the femur is exaggerated owing to their distance from the casette. Also, in the frontal view the torsion angle causes apparent shortening, varying with the external or internal rotation. Again the neck is frequently shortened by the compression nature of the injury. Furthermore impaction adds a small error. On our Bucky table an 8·75 centimetre (three and a half inch) nail is increased by eight millimetres (a third of an inch) unless the limb is externally rotated, which causes foreshortening. In the latter case the Y section of the nail can be seen (Figure XXXIV). When the X ray tube is close to the patient, as in Figure XVIII, the nail is increased in length by about 20%, that is the nail is increased in length by the X ray projection more than 1·25 centimetres (half an inch).

Use of the Nail Starter.

This abbreviated nail on a handle recommended by Smith-Petersen is very useful because it assures a good start. The nail starter is used so that the open "V" of the "Y" formed by the blades looks cranially. Thereby the broadest surface of the nail will lie on the *calcar femoralis* (Figure XXII). Sometimes the cortical bone on the lateral aspect of the femur is very dense. In such cases, if the nail is used without the nail starter as a preliminary the guide wire can be kinked in the following manner: The nail is threaded along the projecting wire and then the canaliculized punch is passed along the wire down to the nail head. Otherwise the nail could not be hit by the hammer because 5·0 or 7·5 centimetres (two or three inches) of wire project out of the head. If the wire was cut shorter the neck shaft angle would not be clearly indicated. When the punch is now hit gently by the hammer, the nail tends to wobble, owing to the movements which can occur between the punch and the nail. The wire may then be kinked just where it penetrates the bone. If the bone is softer and the end of the nail is very sharp, the nail starter is not then essential. Since the wire is really held firmly only by the thickness of the trochanteric cortical bone on the one hand and the head of the femur on the other, and not by the soft cancellous bone of the intervening neck, the importance of a correct beginning as the nail enters the bone requires no stressing, otherwise the wire can be bent within the neck. Johansson recommends marking the bone with a chisel.

When the nail starter has been removed the nail is slipped along the wire until it strikes the bone. Then the nail, held in a forceps or by a piece of gauze, is rotated until its blades fit into the previous markings made by the nail starter.

When the nail is against the bone about 7·5 centimetres (three inches) of wire project beyond the head of the nail, but this is naturally hidden to view after slipping the punch over the head. Therefore a mental note of the direction of the wire is made before slipping the punch along the wire. Also a mental picture of the direction of the nail should be made. The nail is carefully watched as it is being driven into the bone so that no alteration of its direction on account of bending of the wire can occur without being immediately observed. The hammer or punch is not watched whilst this is being done, otherwise the nail may be misdirected as a result of kinking the wire. Thus the procedure is like hitting a golf ball. These directions are particularly important in the case of dense bone which resists the entry of the nail. In these cases the operator tends to hit the punch harder and harder, and then the nail may be driven against the direction of the wire and the wire may then be kinked within the neck, which as a rule contains only very soft bone. This bending is prone to occur at the stage just when the nail begins to enter the head because the latter is always dense—and at times very, very dense—and then requires quite a considerable degree of force to drive it into the bone, so much so that the pelvis of the patient should be steadied by an assistant. Ill-directed blows may then alter the direction of the nail. In such cases it is difficult to remove the wire, which is usually bent about 2·5 centimetres (one inch) from the pointed end (Figure XXIII). A further aggravation of the difficulty from a bent terminal end of the wire is that it may be driven forwards into the hip joint cavity. It is then very difficult to remove. This has not happened to me, although occasionally difficulty in removal of the wire owing to a slightly bent tip has occurred, requiring some harder pulling than can be obtained by any artery forceps gripping the wire. Therefore the instrumentarium should include a "wire-drawing pliers" with parallel acting jaws which can be clamped with a thumb screw.

Should it be impossible to withdraw the wire from the canal in the nail because the end of it has been bent and forced through the head into the hip joint, where it is anchored, then the following suggested alternative courses may be useful for adoption:

1. The peripheral end of the wire is clipped off close to the nail head and the rest of the wire within the nail canal and hip joint is allowed to remain in the hip joint until some months later, preferably when bone union is assured.

2. Another procedure is to cut off the wire near the head of the nail so that there is still about 2·5 centimetres (one inch) projecting from the head. Now the extractor, which, having a small hole up the centre of the central extracting bolt (Figure XXV), permits of the instrument being fitted to the head of the nail despite the projecting wire, can be used to extract the nail. After the nail has been withdrawn about 1·25 centimetres (half an inch), it may be possible to pull out the wire, because pulling on it may now straighten it. If this fails the whole nail is withdrawn. Then it should be possible to pull out the wire. Now the nail is thrust back along the same "Y" track made by the first introduction of the nail. During the operation redisplacement of the fragments could not occur because the limbs have been held by the extension pieces of the orthopædic table. The nail should now be driven in slightly farther than it was before. Since a reintroduced nail never fifts as tightly as after the first nailing, especially as withdrawal of the angulated wire must cause some injury to the cancellous bone, the limb should be immobilized carefully afterwards, preferably in a short plaster cast.[1]

Whereas the above accident is due to kinking the terminal end of the wire, the following accident is due to bending the wire soon after the nail penetrates the bone. This difficulty which has been reported is the pushing of 7·5 or 10·0 centimetres (three or four inches) of wire ahead of the nail instead of the nail sliding along the wire. This appears to be due to an early kinking of the wire soon after the nail has entered the bone by ill directed and violent hammering of the nail. This accident can be avoided if after each 1·25 centimetres (half an inch) of progress of the nail the punch is removed and the length of projecting wire is noted. More length of projecting wire appears as the nail penetrates the bone. If it remains the same length, it must be passing into the bone with the nail *pari passu*. This accident can also be caused by hitting the projecting end of the wire with the striking surface of the hammer, because the wire has not been cut short enough. Thus for example, if the outside end of the wire was only about 2·5 centimetres (one inch) from the end of the punch which is hit by the hammer, then as soon as the nail has penetrated that distance further hitting of the punch means hitting the end of the wire. In such a case the punch should be removed and more wire clipped off. Another cause is that the canal along the nail may be clogged by bone or other foreign *débris*. The wire may not then slide easily within the canal. Also nails made by different manufacturers are slightly different in diameter, also the wires. Therefore we should always test the nails and wires before use.

In regard to the above accidents attention may be drawn to the following dangerous incident which occurred to Seidel (Dresden).

He had exposed the hip joint with a large Smith-Petersen incision, and, having reduced the fracture, inserted a Kirschner wire under direct vision into the neck and head of the femur. X ray pictures showed good reduction of the deformity and accurate introduction of the guide wire. Then the nail was driven along the wire. He now found that it was impossible to withdraw the wire. The X ray pictures showed perfect introduction of the nail, but the wire had penetrated the floor of the acetabulum and entered the pelvis to a distance of eight centimetres. A vaginal examination showed that the wire was passing behind the uterus, and the rectal examination enabled the palpating finger to detect the wire behind the rectum which thus clearly was not penetrated. He now closed the hip wound and through an abdominal wound in the left iliac fossa exposed the bladder extraperitoneally. The wire was found perforating the bladder in connexion with which there was a small extravasation of urine. He clipped off the wire close to the bone, within the pelvic ring, and repaired the bladder wound. Presumably the other portion of wire could then be removed from the nail, although he did not mention it. He reported that the patient made a good recovery from the operative procedures.

Impaction.

When the nail has been driven into bone right up to the head, the wire is then withdrawn. Any traction on the limb of the affected side is now loosened slightly before the Smith-Petersen impactor is used to jamb the fragments well into one another. If this is not attended to the very opposite effect follows the impacting blows, that is separation of the fragments. Also there develops a consequent loosening of the nail due to the backward and forward movements of the distal fragment along the nail at each blow. After the impaction it is usual for the nail to stand out about six to eight millimetres (one-quarter to one-third of an inch). This need not be driven into the bone again until the control X ray pictures have been made. Thereby penetration of the hip joint can be avoided. The impaction insures a firmer fixation of the fracture because it "takes up" any gaps or defects due to loss of bone from the compression nature of the injury, especially at the upper and posterior aspects of the neck. The importance of this impaction cannot be exaggerated, as the following case shows (Figures XXXVI to XLV):

At a demonstration at a meeting of the Royal Australasian College of Surgeons this year, I had completed the operation in well under one and a half hours. On testing the hip joint movements I thought "grating" could be detected, thereby indicating that the sharp end of the nail had penetrated the articular cavity. On attempting to extract the nail I found that the head had become counter-sunk completely into the bone. This was due to very soft atrophic bone. I think also that as a result of using too small a skin incision the impactor had not fitted properly around the nail head. Thus the impactor had increased the counter-sinking of the head. At any rate a small amount of removal of bone in the distal aspect of the nail head was required before the extractor could be fitted to the nail head. When eventually the extractor was fitted it would only withdraw the nail about ten millimetres (one-quarter of an inch) into the tube of the extractor. It was then discovered that the extractor could not be removed from the nail, the head of which was over size and jambed on the casing of the extractor. Eventually

[1] Felsenreich's instrument, made by Odelga (Vienna) grips the wire after the manner of Kirschner's wire strainer and should withdraw any kinked wire without disturbing the nail.

after some persistent pulling the whole nail and extractor were pulled out *en masse*. This could not have occurred unless the bone was so soft. Thus after an hour's work in perfectly reducing the fracture and inserting the nail, the latter now remained in my hand instead of in the femur. Rapidly picking up another nail I pushed it easily along the track of the original nail and then tapped it. X ray examination showed perfect position of the fragments and the nail (Figures XL and XLI).

Three lessons could be learnt from this: (i) The firm impaction prevented, temporarily at least, any disarrangement of the fragments; (ii) at least two nails should always be at hand for any operation. If only one nail had been available in this case, the whole procedure would have been a total failure; (iii) all nails should be tested to see that they fit the extractor.

In this case there were five nails, only three of which I had tested.

In regard to the aftermath of the above case, six weeks later an X ray examination showed some beginning separation of the fragments for which a second operation was performed (Figures XLII to XLV). After a further two months the nail again loosened. The patient died from general debility about four months after the operation, although at one stage she left hospital. No weight bearing had been permitted.

Impaction is gently performed, otherwise the trochanteric bone around the head may become crushed and splintered. This will predispose towards *coxa vara* developing, because really the nail has only two main supports, that is the compact cortical bone of the trochanteric region and the dense head. When the nail, however, lies in the lower third of the neck, it obtains a firmer grip from the denser cancellous bone associated with the *calcar femoralis*. This position also insures a long oblique disposition of the nail, which counteracts the tendency to *coxa vara*. Thus the nail is introduced well down in the subtrochanteric fossa. Unfortunately this condition, with of course total failure of the whole operation, can develop despite perfect reduction and insertion of the nail, even when followed by immobilization in bed for three months. Thus Felsenreich had four such experiences of post-operative loosening, for which secondary insertion of nails was performed on two occasions with successful results. Johansson had five similar experiences and again reduced the fracture with a secondary nailing in each case; in one case a third operation was required. Lelio Zeno (who uses arthrotomy for the nailing) has informed me that he had two such dismaying results, despite the above treatment, and I have had three cases. Anschütz (Kiel) reported a case of loosening of the fragments eight months after apparent healing had occurred. He recommended in such cases driving the nail into the floor of the acetabulum. This loosening is just as likely to occur with the large open incision of Smith-Petersen. But in such a case the surgeon would hesitate to perform the operation a second time. The cause of this loosening after the operation has been performed with technical perfection may be due not only to atrophic bone changes in the distal fragment, but also to aseptic necrosis and sequestrum formation of the head fragment. The primary withdrawal of a nail, even though slight, by the extractor because it has entered the hip joint at the first operation, must also predispose towards this later loosening. In regard to the secondary changes in the head of the bone, Axhausen, Bonn, Phemister and many others have shown that recovery of the head can still occur even after almost complete necrosis because all parts of the head are not dead. Therefore we cannot agree that a dense devascularized head necessarily contraindicates an extraarticular osteosynthesis. New formation of bone can occur, often with secondary deformity of the head. This has been observed, particularly in impacted fractures; so much so that Mouchet suggests that such an injury, undetected at the time, may be the cause of some cases of post-traumatic arthritis (Figure XXIX), such as "mushrooming" of the head.

Conclusion of the Operation.

The wound is closed with one temporary suture. The patient is then removed from the orthopædic table and placed on the trolly. A full range of movements of the joint is gone through. If the sharp end of the nail has penetrated the articular surface of the head, grating can be felt, but not invariably. The nail can be slightly withdrawn if necessary and the range of movements tested again. The wound can, if necessary, be now closed by sutures. Then a frontal X ray picture is made. Then the thigh is flexed at 90° to its last position and the lateral view of the hip joint made (see Figure III) because the lateral view by this method is absolutely true and undistorted and, using a Lysholm grid, much better than that obtained by the X ray tube in the perineum. The nail may require, as a result of the information obtained by this X ray examination, withdrawing or knocking in further. If so, the sutures, if already inserted, are removed. Finally about three fine silk sutures are used to close the muscle separation over the head. Then the skin wound is closed by three deep biting sutures of silkworm gut which pass just superficial to the *tensor fasciæ femoris*. No drain is used because the incision is so small and the above sutures avoid any "dead spaces". The skin is painted with mastic gum. A thick pad 10·0 by 7·5 centimetres (four by three inches) is stuck on and further anchored by three strips of adhesive strapping. Then soiling of the wound cannot occur. The date of the operation is written on the adhesive and the dressing is not changed for three weeks. Earlier removal of the sutures may result in the wound gaping, in part, because the healing process in the elderly is often slow. A slight gape could cause secondary infection of the deep structure, and in the presence of a foreign body like the nail head would be very undesirable. If the patient is a wasted or very thin subject, the nail is closer to the skin and this possibility is more likely.

After-Treatment.

The limb is placed on a Braun splint. Excessive outward rotation of the limb is prevented by suspending the foot with strapping and a spreader attached by a cord to the top cross bar. Occasionally, if the bone is found to be atrophic and soft, offering very little resistance to the entry of the nail, traction is added for six weeks with strapping extension from the thigh and leg. The traction assists immobilization, but also overcomes muscle

spasm, separates the articular surfaces, and thereby diminishes pain. The splint should be placed in the abducted position, otherwise an adductor spasm with subsequent contraction or even *coxa vara* tends to develop occasionally. Knee exercises begin within a day or so. A sling around the ankle is suspended to an overhead pulley. The patient can then assist to flex the knee. After fourteen days the limb is removed from the splint and the patient is taught to use the limb freely in bed, at first resting it on a pillow. Much assistance is obtained with a sling around the foot, and attached to the sling is a cord which the patient holds, thereby assisting flexion movements of the leg and thigh. The patient may sit in a chair after another week.

If the patients are elderly (seventy-five or more), especially if they have incontinence of urine whilst lying in bed, and if there is also a tendency to skin complications, they may sit out of bed in a chair within a few days. Bed sores, if present, heal rapidly with Löhrs ointment (one part of raw cod-liver oil, which is naturally sterile, in three parts of sterilized vaseline).[1] We use this for all infected wounds, burns *et cetera*. It generally obviates skin grafting in a remarkably gratifying manner. Böhler applies a small spica cast immediately. It reaches to just above the knee. The thigh is not abducted. He allows weight bearing after fourteen days if the reduction of the deformity and insertion of the nail have been perfect, sometimes even without this cast, which at any rate cannot be very effective, because the limb is not immobilized in abduction. Consequently walking does not tend to jamb the fragments together except in so far as the nail, being very oblique, favours this. This treatment cannot be recommended for general adoption.

The use of the Thomas walking caliper is inadvisable since it does not immobilize the hip, and is disliked and ill-borne by old people, especially if the thighs are large. It tends to slip off the ischial tuberosity, and then the length of the splint acts as a long lever tending to strain the fracture site, especially should any adduction strain result [Figure XXIV (a)]. The ingenious saddle splint designed by Hugh Trumble of the Alfred Hospital, Melbourne, seems far superior, but we use no splints for these cases.

The Period after Operation when Walking may Begin.

It is very difficult to ascertain the period after operation at which walking may begin, and there is no general agreement except that early weight-bearing under four to six weeks at least is too risky to be justifiable. *Coxa vara* and failure of the operation may result from premature weight bearing. So disastrous is the occurrence of a redislocation of the fragments due to early weight bearing that the majority of surgeons are very conservative in permitting it. In my own limited experience the following points are used as a guide.

When the fracture line tends to be horizontal rather than vertical, then walking is permitted after four to six weeks, but actual weight bearing without the help of sticks or crutches is seldom advised under three months. Figure XXVI shows Pauwel's conception that the type of fracture line, whether horizontal or vertical, determines the likelihood of bony union developing. Of course, herein lies the secret of a successful Schanz osteotomy for an ununited fracture because the tilting of the trochanteric fragment into strong adduction not only stretches the pelvi-trochanteric muscles, but disposes the fracture line into a horizontal plane. Then after the femoral shaft has united with the trochanteric fragment, with abduction of the former, the head of the femur literally sits upon the trochanteric fragment and walking tends to impact the fragments. When the fracture line is vertical, "shearing movements" tend to develop.

If the patient is not very old, and therefore has less decalcification and fatty replacement of bone, if the nail has been perfectly inserted in the lower third of the neck with the open "V" of the blades looking cranially (the nail lying very obliquely, 130°), if the fracture has been almost perfectly reduced, if the bone resisted the introduction of the nail and was not soft from bone atrophy and there was no splintering or comminution, if X ray examination after four weeks reveals no gap defect (Figures XXXV and L), if the patient is not over 64 kilograms (140 pounds) in weight, then walking after five to six weeks is allowed. When the bone has been found at operation to be very soft, then loosening and separation of the fragments are liable to occur no matter what we do. Herein the nail may be an insufficient internal splint, and can fail in its object after two or three weeks, even if the patient merely lies in bed. In such a case the limbs should be then immobilized in a short plaster hip spica. If the patient declines to wear this, prolonged immobilization on a Braun splint is the alternative. In any case we anxiously await the result of treatment.

The method of performing secondary operation for cases in which the nail has become loose and the fragments disarranged is rather simply and easily done, as follows: Under spinal analgesia, with the patient on the orthopædic table, the head of the nail is exposed by the original incision, and for the nail head to be found easily in the incision, the limb should be internally rotated as for the first operation. Otherwise it is difficult to find the head, and much unnecessary freeing and cutting of muscle fibres are required. The nail is now withdrawn about 2·5 centimetres (one inch) so that it no longer is in any part of the *caput femoris*. Then the wound is temporarily closed and covered with a sterile towel. We now proceed to reduce the deformity exactly, as already set out. After this frontal and lateral X ray pictures are made to control the result of the manipulations. If the reduction is satisfactory the wound (temporarily closed) is reopened and the original nail is withdrawn. Another nail, slightly longer (six millimetres or a quarter of an inch) is easily thrust along the original "Y" track of the nail. It is then driven hard into the caput or beyond it, into the hip joint. Finally impaction is carried out. If the nail has become very loose in the neck, for example after three months, then the simple operation

[1] This very excellent dressing is put up now by Rocke, Tompsitt & Company, Melbourne, as "Unguentoline", which is sterile and deodorized.

described above would be ineffective. This operation is performed on the assumption that if a longer nail is driven right through the dense head, then the expanded nail head fitting against the lateral aspect of the femur will hold the fragments together. In later cases it will be advisable to drive the nail through a different part of the neck altogether.

Crutches are used so that the full weight is not made to bear on the neck and head. After two to three months no support is necessary unless the patient desires to use a stick. It will be necessary generally to teach the patient to use crutches and to walk. No massage or passive movements are recommended, because they have not so far been found to be necessary. Crêpe bandaging from the toe clefts to the groin should be applied if the limb swells.

How Long Should the Nail Remain in the Neck and Head of the Femur?

All authorities are agreed that the nail should remain in position for at least twelve months. This is important. Experience which has been accumulated by various observers since the introduction of the Smith-Petersen nail, has shown that no deleterious effects in the bone follow its presence after one or two years at least, providing the nail is made of the best stainless steel. On the other hand, many reports show that redisplacements have frequently followed removal of the nail in under six to nine months. Herein lies the advantage of the nail and the disadvantage of the large plaster cast, because some of the failures occurring after the use of the plaster cast might have been turned into successes had the period of immobilization been longer. The presence of the nail is a protection against any sudden twist refracturing the neck, a possibility for at least a year. Zeno reported a case of trochanteric fracture following such an injury when a subcapital fracture had been fixed by a nail some time previously. The nail was still in place, of course, and protected the neck itself from further injury.

Whilst the presence of the stainless steel nail in the bone is relatively non-irritating, it is not entirely so, as shown in Figure XXX, in which some slight rarefaction is apparent around the nail. Nails which I have removed after months show slight erosion of the stainless steel nail itself, near the head. This, however, may be due to the fact that heat (caused by welding on the head to the nail which was formerly used) has affected the stainlessness of the steel.

Whereas the nail can be removed only by a special extractor (Smith-Petersen's is based on the principle of a corkscrew, Broomhead's grasps a groove in the periphery of the head, while my own is the same as a motor car wheel extractor; my own can withdraw a nail even though the head is embedded in bone) within the first few weeks or months after its insertion, it can be easily pulled out after six months. I have removed only three nails after six months. They could be removed with the fingers. Two years is the longest period in which nails have remained in the bone. Further experience is necessary before it is known whether the nail eventually does any harm.

Kotrnetz found that a strain on the femoral head and neck of a bone, which had been experimentally broken and then fixed together with a Smith-Petersen nail, if above 35 kilograms (60 pounds), resulted in loosening of the nail. The cancellous bone in the distal fragment, that is the neck of the femur, was cut into by the nail, but the bone of the head, which is very dense, withstood this weight of 40 kilograms (88 pounds), though it brought the nail through the vertical bone of the neck on to the *calcar femoralis* with a *coxa vara* deformity. Figure XXII (D) shows how, in my own experiments, further weights not only resulted in the head end of the nail cutting upwards into the trochanteric region, but that the head was also cut into. Some observers have noted that no extensive cutting of the cancellous bone of the head occurred. This naturally would depend upon the mobility of the head in the acetabulum. Some slight shortening of the neck (with healing of the fracture) is inevitable, as this occurs also in the fractured shafts of long bones owing to bone absorption from the granulation tissue of callus formation. The head of the nail then in some cases becomes extruded. The patient may in these circumstances complain of an uncomfortable "click" on rotating the limb. In one case an adventitious bursa had formed in connexion with the head. Sometimes the nail may be defective, and it has broken. Therefore it has been proposed that nails should be examined by the X rays for any flaws before they are used. The nails will withstand 200 pounds bending stress. The head used to be "spot" welded to the nail and thereafter the nail had to be treated by heat again in order to restore its stainless character and render it less brittle. Engineering firms have refused to take any responsibility for this heat treatment. Hence many nails after they have been cut and drilled, and after the head has been welded, have turned out failures. Consequently the cost was high. This difficulty has been recently overcome, and the nails can be made more easily with the heads and blades all in one piece, because of an engineering improvement. Felsenreich has increased the width of each blade by two millimetres, and now allows earlier walking (three weeks). Johansson uses rather small nails. The width of the blades in the nails we use is mid-way between these two sizes.

Simplification of the Method.

Simplification of the method is not only desirable but inevitable, as various surgeons become interested in and practise the method. Simplicity is, of course, to be aimed at in all surgical technique. This advantage does not make it always easier for the tiro because such simplicity is gained by experience and may conceal a great deal of skill. With our present conception it must always be difficult to introduce a nail from the lateral aspect of the femur through a small skin incision into the head of the bone, which is about ten centimetres (four inches) deeper. Any improvements in the direction of simplicity and easiness, which make the method more valuable because it can be widely used, will not be discovered by those who set out to perform the operation in a hurry with lack of preparation and assistants, with no systematic planning of the

steps and with inadequate apparatus. The highly developed and beautiful surgical instruments and apparatus provided nowadays are sometimes not appreciated because the simplest method is preferred, even though the latter may be inefficient and the work suffer accordingly. Thus cases have occurred in which the "blind" operation was performed with only one nail in the armamentarium which, being introduced incorrectly, could not be removed because a nail extractor had not been provided. Again, if the patient is not firmly fixed and if the legs are not held immovable on an orthopædic table after the reduction, then the fragments may become redislocated. Thus whilst the nail is being driven in, the pelvis may be shifted by the blows. This is a difficulty which can hardly arise when a screw traction apparatus is used.

With the particular method outlined in this paper, it has been found that any curtailment of the full series of X ray examinations may introduce errors. The correction of these, in the long run, prolongs the period of operation. With our arrangements a shock-proof X ray apparatus is essential. A smaller and less expensive portable Philips "Metalix" unit than that illustrated in Figure XXI has been used at times with satisfactory results. An orthopædic extension apparatus for the legs is desirable, if not absolutely essential. At any rate some method of holding the legs is very necessary, and it is comparatively easy to improvise such an extension apparatus (see page 144 in "Treatment of Fractures in General Practice", Volume 2, by W. H. Ogilvie in Pocket Monographs on Practical Medicine series). If the hospital at which the operation is performed has no dark room for developing the exposed X ray films, then the operation can be performed at night.

Recently Hansson and Hellgren have described a method for introducing the canaliculized nail which can be performed in any X ray department having a fluoroscopic horizontal screening table (trochoscope) supplemented by another X ray tube on an ordinary vertical tube stand, neither X ray tube being "shock-proof". Such an equipment is the standard one in X ray departments in this country. No leg extension apparatus is used. Counter-extension is supplied by a strap encircling the groin on the affected side and carried up over the shoulder of the same side to the head end of the table. Thereby traction in the limb on the same side as the perineal strap will be followed by tilting downwards of the pelvis. After the fracture is reduced by a method similar to Leadbetter's manœuvres, extension is maintained on the injured extremity by a loop of canvas which is placed around the ankle and which is then attached to the bottom corner of the table, resulting in slight abduction. Internal rotation is obtained, apparently less satisfactorily, by another loop of bandage or canvas strapping placed around the knee and tied to the other side of the table. Slight flexion of the knee results. The postero-anterior view picture is made with the X ray tube beneath the table. The lateral view picture is made by flexing the uninjured thigh and leg, as in Figure III. During all these manœuvres the three canvas strapping loops are said to maintain the reduction. The authors have not published any X ray pictures of treated cases, but intend these to be included in a later paper.

Felsenreich, of Vienna, who follows Johansson's technique in exposing the lateral aspect of the femur before inserting the wires, also recommends the use of two X ray tubes because thereby there is no disarrangement of sterile sheets, which tends to occur with the changing of one tube when used for both the frontal and lateral views; also time is saved. He uses no extension on the "good leg", which is bent at right angles at the knee with the foot resting on a stool. The injured extremity is held in rather marked abduction by an extension piece. This abduction, however, is largely nullified by the pelvis tilting because the other limb is not fixed. One X ray tube is fixed above the hip for all the frontal views. The other tube is shock-proof, and is situated between the legs.

If the fluoroscopic examination which I have described as essential is used, then even with a non-shock-proof X ray tube we can use the method if the tube is placed as for taking ordinary antero-posterior pictures; but the fluoroscopic examination is carried out with the simple and cheap right-angled fluoroscope (see illustration in *Journal of Bone and Joint Surgery*, advertisement section, page 8, January, 1935). Such an apparatus has been favoured in France for a number of years. The fluoroscope is placed under the hip joint, the ordinary X ray tube being above the hip, and the operator views the image on the screen by means of a mirror through a long extension piece placed at right angles to the screen.

The great advantage of the fluoroscopic insertion of a preliminary guide wire behind the bone is that an almost perfect guide for the subsequent drilling of the wire into the bone is provided.

Conclusion.

The report of experiences in thirty-six cases of extraarticular osteosynthesis may be summarized as follows:

1. The average age of the patients was nearly seventy. The oldest was eighty-five (there were eight patients between seventy-nine and eighty-five), and the youngest sixteen years, with no deaths.

2. The average period which elapsed between the accident and the operation was ten days, excluding two cases of some months' duration.

3. The reduction was in all but one case as perfect as that obtainable by open reduction. In that case there is some increased varus angle of the neck (see Figures LI and LII), but the fracture has united. The reduction was successfully performed at the first attempt, except in three cases, which required two attempts before reduction was obtained.

4. The guide wire in the bone was drilled in perfectly at the first attempt in nineteen cases. Two attempts were required in ten cases, and three attempts in seven cases.

5. The average time of the operation was nearly two hours. I could claim that most of the operations were of an hour or less in duration, but I have included as the beginning of the operation the

moment the patient is got ready for the spinal analgesia (which I have now abandoned for local analgesia). Since we wait eight minutes after the intrathecal injection before placing the patient on the orthopædic table and since it then takes about twenty minutes to adjust the patient on the table, it will be seen that well over thirty minutes are included which do not properly belong to the operating time. Furthermore I have included in the time of operation the delay which occurs whilst the hip with the nail in place is being photographed by X rays before the patient leaves the theatre. We then wait about ten minutes until those X ray films have been developed. In most of the cases, especially lately, the time which elapses from the reduction of the fracture to driving in the nail is not much over a half hour. However, time does not matter, because everything is performed slowly and steadily, the patient is warm and comfortable, and in not one single case up to the present have I had the slightest anxiety as to the general condition of the patient. Gentleness and deliberation are the watchwords with which we combat the criticism of being tedious.

6. Except in the one case which resulted in death, not one patient showed any distress after the operation.

7. The average stay in hospital after operation has been five weeks; some patients have remained only two weeks, or less.

8. The average period after operation in which walking was permitted was seven weeks.

9. In the thirty-six cases there was one death following operation. There were four failures to obtain bony union; eight patients are still under observation. In five of these, at least, bony union is most probable. In twenty-three cases bony union occurred. The death can be attributed to an error in technique, because it resulted within forty-eight hours of a second operation to withdraw slightly a nail which had been knocked through the floor of the acetabulum into the pelvis. Two other patients died four and five months after operation, which was not therefore responsible. In one of the patients bony union was present. In the other case (that of a debilitated subject), the nail slipped out of the atrophic bone. Of the four failures three were due to mistakes. The mistakes were: too early weight bearing (after five days) in one case; too short a nail in the second case; and in the third case a misdirected nail, which could not be corrected owing to a faulty extractor and nail preventing removal of the latter. The causes of the misdirection were in the first place failure to drill the guide wire into the head sufficiently so that it would direct the nail and in the second place hitting the nail too hard. In the light of these experiences of mine and those which have been recorded as having occurred to other surgeons, such mistakes should be avoidable in the future. A careful study of these errors should enable surgeons who may now intend to carry out this most conservative and effective treatment to do so without having the above painful experiences. Thereby they can avoid the pitfalls which have fallen to the lot of pioneers in this method. The various warnings throughout this article have not been given with any sense of superiority, because in most instances they have been prompted by my own difficulties and errors.

Therefore I believe that extraarticular osteosynthesis according to the outlines invented and described quite independently by Johansson and myself, if properly performed, is the safest and most appropriate method which has so far been brought forward for the deliberate treatment of subcapital fractures of the neck of the femur. The surgical world owes a debt of gratitude to Smith-Petersen and his associates for inventing the nail.

Legends to Illustrations to be found in the Supplement.

Figure XXVII.—A truly "impacted" fracture of the medial part of the neck. The neck has penetrated the head, with increase of the valgus angle. Increased abduction is also present. Treated by rest in bed only for six weeks, thereafter crutches, but no weight bearing for a further six weeks. Note in the diagram of the lateral view the marked compression of the dorsal aspect of the neck. Hence the secondary deformity which has developed in a similar case (see Figure XXIX).

Figure XXVIII.—An insecurely "impacted" fracture of the head with no penetration of the medial part of the femoral neck. *Coxa vara* with an adduction deformity is present, the antithesis of the *coxa valga* (Kocher) or abduction type (Böhler). This case was treated by extraarticular osteosynthesis (see Figures LI and LII, the same patient).

Figure XXIX.—Secondary deformity of the head in an impacted (*coxa valga* type) fracture which occurred seven years ago. A lateral view of this case would show that most of the deformity was on the posterior aspect.

Figure XXX.—Case II. Frontal X ray picture taken twelve months after operation. The patient (aged fifty years) returned to work as a boilermaker three months after the operation. The top arrow indicates the site of the old fracture. Note that there is some rarefaction about the nail, which the patient declines to have removed.

Figure XXXI.—Case II. Lateral X ray picture taken twelve months after the operation.

Figure XXXII.—Case IV. Frontal view showing the nail in the pelvis due to hitting the nail too hard in very soft atrophic bone. No X ray control being available because the apparatus broke down after the reduction and insertion of a wire behind the neck, the length of the nail required was unknown.

Figure XXXIII.—Case IV. After a week the nail was slightly withdrawn. The patient, aged sixty-four years, died from "acute pneumonia", which supervened next day (pulmonary embolism?), due to the second operation.

Figure XXXIV.—Case IX. Frontal view made three months after the operation. The limb is externally rotated, and thus the neck is hidden by the great trochanter, especially by the posterior intertrochanteric ridge.

Figure XXXV.—Case IX. Frontal view after nine months, but made with the limb internally rotated, thereby displaying the whole length of the neck. Note that despite bony union in the upper part of the neck there is non-union in the lowest part. (See also Figure L, lateral view of same patient.)

Figures XXXVI to XLV are from Case XVIII. (Operation performed at annual meeting of the Royal Australasian College of Surgeons.)

Figure XXXVI.—Case XVIII. Frontal picture taken immediately after a good correction of the deformity and after the first guide wire has been inserted under direct fluoroscopic control behind the neck of the femur.

Figure XXXVII. Case XVIII. Lateral view immediately after the manipulation and introduction of the wire behind the femoral neck under direct fluoroscopic control. Note the perfect reduction and also that the wire behind the neck is actually in this case penetrating the head. This indicates very soft and atrophic bone (see later).

Figure XXXVIII.—Case XVIII. Frontal view after the two guide wires have been drilled into the bone of the neck and head. All are parallel, and are at different depths in the bone in order to be able to distinguish them. The middle one is the wire behind the neck. It is slightly broader than the others because it is farther from the film. The lowest wire is in the best position.

Figure XXXIX.—Case XVIII. Lateral view showing the two wires in the bone. The middle wire is the better guide for the nail. This corresponds with the lowest wire in the frontal view, also the better wire in that view.

Figure XL.—Case XVIII. Frontal view with the nail lying in the lower third of the neck. The nail should have been driven farther into the head, especially as the bone was very atrophic.

Figure XLI.—Case XVIII. Lateral view showing a good position of the nail.

Figure XLII.—Frontal view six weeks later showing beginning loosening of the nail and displacement of the fragments (*coxa vara*).

Figure XLIII.—Case XVIII. Lateral view showing that the nail is slipping out of the head. Displacement is beginning.

Figure XLIV.—Case XVIII. Frontal picture after second operation and driving into the head of a longer nail. The reduction of the deformity is not so perfect as at the first operation.

Figure XLV.—Case XVIII. Lateral view after the second operation. Note the maximal amount of bone engaged by the nail. Nevertheless, although no weight bearing was allowed, the nail again loosened. The patient died four months after operation from general debility.

Figure XLVI.—Case XVII. (Operation performed in the presence of Dr. Melvin S. Henderson of the Mayo Clinic.) Frontal view immediately after operation of a very comminuted fracture in a patient, aged eighty-four years. The reduction is good and the nail lies in the ideal position.

FIGURE XLVII.—CASE XVII. Lateral view showing good reduction, despite the comminution of the neck and head. Nine weeks later the X ray examination showed union with the same position of the nail and fragments, but the patient had developed a carcinoma of the bladder. On admission she had symptoms of cystitis, so common in these cases, but the true nature of the trouble was overlooked. At *post mortem* examination five months later the fracture was firmly united in perfect position. The nail was still very tight.

FIGURE XLVIII.—CASE XIX. (Operation performed at Royal Australasian College of Surgeons annual meeting in Melbourne, 1935.) Frontal view taken four weeks after the operation. Ideal reduction and insertion of the nail.

FIGURE XLIX.—CASE XIX. Lateral view of the same case. This patient is now walking well, nine weeks after the operation.

FIGURE L.—CASE IX. Lateral view corresponding to Figures XXXIV and XXXV shows considerable posterior impaction with bony union behind, but none in front. The patient is walking well, with no pain.

FIGURE LI.—CASE V. Frontal view corresponding to Figure XXVIII. The reduction is not perfect, but bony union resulted.

FIGURE LII.—CASE V. Lateral view shows that internal rotation might have been either insufficient or that lateral traction was not used and thus the distal fragment rotated the head backwards. (See Figures XIV and XV.) Another explanation, the true one, is that the bandages holding the foot to the internally rotated foot piece slipped. The foot then rotated into the mid-position, and this was not noticed. The end of the nail has penetrated the front of the head. This was withdrawn slightly before the patient left hospital. Final result was bony union and good function, with no pain.

FIGURE LIII.—CASE X. Frontal view after a good reduction, but note the gap below the neck due to some overextension and abduction. Number 1 is the wire behind the neck, because it is broader (being furthest from the film), 2 and 3 are in the bone, 3 being the better directed.

FIGURE LIV.—CASE X. Lateral view after reduction. Number 1 wire is behind the neck, 2 and 3 being in the bone. Number 3 is the better directed wire, and happens to correspond with a better directed wire in the frontal view. Note the perfect reduction in both views.

FIGURE LV.—CASE X. The nail has been driven along guide wire 3. It is nearer the lower part of the neck and parallel with the lower border. The neck is impacted, with slight valgus, into the head.

FIGURE LVI.—CASE X. Lateral view taken after three months shows bone union. Note the callus on the front of the neck. Patient is walking well now, with no pain or limitation of movements.

FIGURE LVII.—CASE XXVII. Patient, aged seventy-nine years, operated upon under local analgesia ten days after the injury. There are three wires in the bone and one behind the neck. All are superimposed in this view, which shows a good reduction.

FIGURE LVIII.—CASE XXVII. Frontal view after introduction of the nail along the guide wire. Note how the impaction has taken up the gap which was between the fragments in Figure LVII.

FIGURE LIX.—CASE XXVII. Lateral view showing a good reduction, also the wire behind the neck and three wires in the neck and head itself. Any one of these three wires would act as a satisfactory guide for the nail, but the lowest one (number 3) in the head was used because it permitted a longer nail to be used, as shown in Figure LX.

FIGURE LX.—CASE XXVII. Lateral view immediately after introducing the nail. Note how by selecting the lowest wire (number 3) in Figure LVIII the maximum length of bone in the head was engaged. With the two other wires shorter nails would be necessary. Note the good reduction, also the oblique line of the fracture.

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POISONOUS SHELLFISH.[1]

By Joyce Allan,
Assistant Conchologist, Australian Museum.

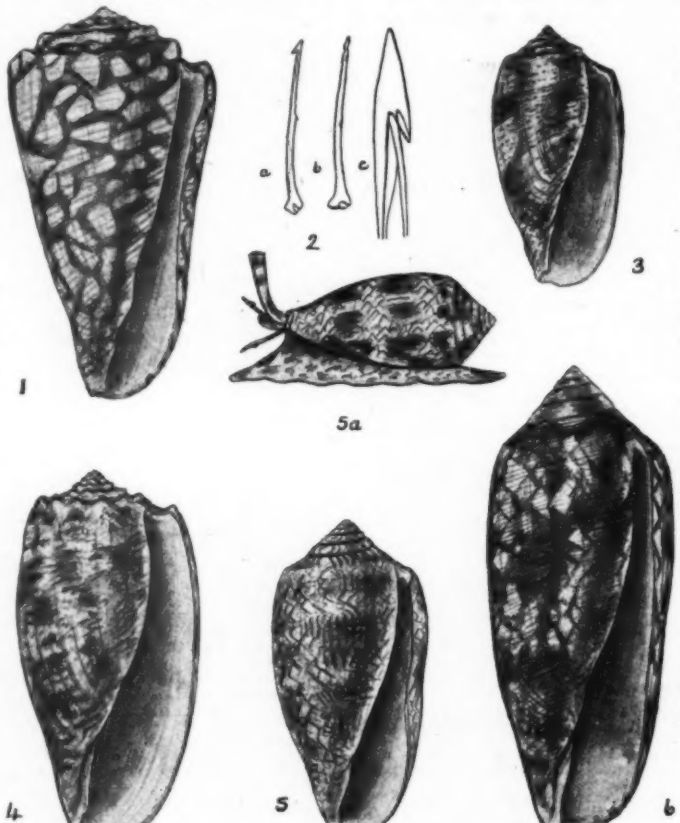
It is reported that a young man has died in Queensland from the effects of the bite or sting of a shellfish. While on a pleasure cruise through the Whitsunday Group of the Great Barrier Reef he was handling a prettily marked shell at Hayman Island when the animal within it pierced his hand. Some time later serious symptoms developed, the patient was hurried to the mainland, by which time he was unconscious, and he died on the way to hospital.

Though this is the first record in Australia of a death from a bite of a shellfish, or even of an attack of this kind, there are many instances recorded of similar happenings in the South Pacific islands. Scientists have known for many years of the dangerous qualities of certain shellfish and have therefore handled them carefully when removing them from the sea.

The shellfish responsible for the attacks in the South Pacific have in each case been certain species of cone shells, a large family of brightly coloured shellfish living in warm waters, and particularly common in the South Pacific islands and along the Great Barrier Reef. These shellfish haunt holes and fissures of rock and the maze of coral reefs, where they lead a predatory life, boring into other shellfish and sucking the juices from their bodies. It is almost certain that the species responsible for the recent death in Queensland is one of the cone shellfish. No other types of shellfish have as yet been known to inflict poisonous wounds, though it is suspected that several may be capable of doing so should the occasion arise.

In numerous scientific publications references have been made to the poisonous qualities of the cone shellfish, and instances quoted where people, mostly natives, have been bitten. These references were given in 1912 by Dr. J. Burton Cleland, at that time stationed at the Government Bureau of Microbiology, Sydney, in a paper published by him in the *Australasian Medical Gazette*, September 14 and September 21, 1912, on "The Injuries and Diseases of Man in Australia Attributed to Animals".

This very interesting paper records all the cases known of poisonous bites from shellfish from the years 1850 to 1911, and, although at that time there was no record of such an accident having occurred in Australia, as the shellfish responsible were in all cases cone shellfish, and as the different species concerned are also found in Queensland waters, the author rightly considered it advisable to include them in his paper. The recent death has shown that such cases can occur in Australia.



1 = *Conus marmoreus*. Colour of shell, white or pinky white, chocolate reticulations so arranged as to expose white in rounded or triangular spots, inside of shell white. Size, four to five inches.
2 = A tooth of *Conus marmoreus*. Figures *a* and *b* are different views of the same tooth, and Figure *c* is the point of the tooth, much enlarged. (After Troschel.)
3 = *Conus tulipa*. Colour, violet white, clouded with chestnut, revolving lines of minute chestnut and white reticulations; inside shell, violet. Size, two to two and a half inches.
4 = *Conus geographus*. Colour, pink or violet shade, clouded with chocolate brown, inside violaceous white. Size, three to five inches.
5 = *Conus textile*. Colour, yellow brown, and undulating longitudinal and semicircular lines of chocolate brown, with triangular white spaces. Size, two and a half to three and a half inches.
5a = Side view of shell and animal of *Conus textile*, showing proboscis and head tentacles, bearing eyes, extended at anterior end of shell.
6 = *Conus aulicus*. Colour, rich chocolate brown, with fine revolving darker lines, overlaid with subtriangular white spots, some large. Size, three and a half to five and a half inches.

Shellfish Responsible for Poisoning.

In all, five different species of cones were responsible for the bites recorded amongst inhabitants of the South Pacific islands. The scientific names of these are *Conus textile, Conus tulipa, Conus marmoreus, Conus geographus* and *Conus aulicus*, all easily recognized species, *Conus textile* and *Conus marmoreus* having the most outstanding colour patterning. If a cone

[1] Published by permission of the Trustees of the Australian Museum.

shellfish was responsible for the death in Queensland, it was quite possibly *Conus textile*, because that species occurs so commonly on the Great Barrier Reef, particularly round the islands included in the Whitsunday Group.[1]

The poisonous bites from cone shellfish known to science occurred in New Guinea, New Hebrides, New Caledonia, Tonga, Samoa, Fiji, New Britain, the Carolines, and the Society, Sandwich and Loyalty Islands. In these places natives were generally the victims, and one is known to have died from the effects. The natives are well aware of the poisonous bites some of the cones can inflict, and have been observed in New Britain cutting small incisions round the place where they have been bitten. It is their belief that unless this is done and the blood is allowed to flow freely, the victim will die.

In the case at Fiji the victim was a European woman, who was bitten while extracting the animal from a *Conus geographus*, and, although the paralysis which almost immediately resulted from this bite lasted only until the following day, it was quite a month before she felt completely recovered.

The Manner of Attack.

The manner in which the shellfish attacks its victim is rather extraordinary. It is stated earlier that cones are predatory animals which prey on other shellfish and suck juices from their shells. They are able to do this by means of a long, tubular, fleshy structure, known as a proboscis, which can be retracted at will, but when extended reaches beyond the anterior end of the shell. Opening into this tube is a radula-sac containing roughly two rows of numerous teeth and a bundle at the end. When grabbing its food, or when opposed by any outside agency, such as the hand of a human being, the cone immediately shoots out this proboscis and the object is pricked by the sharp points of the teeth, which are hollow and have a swelling at their bases. The poison reaches them from a special poison gland.

The Symptoms of Poisoning.

The symptoms experienced by a person suffering from this shellfish poisoning are, after the first pain of the prick from the sharp pointed teeth, acute pain and considerable swelling, with local numbness which leads to paralysis extending in severe cases throughout the body. The tissue surrounding the minute point of puncture has a bruised appearance, and one or more tiny punctures may be seen. Muscular control goes, and even the head has to be supported in such a way to allow breathing to continue. Speech becomes thick and indistinct, the throat is considerably affected, the eyesight is dim, and a feeling of "pins and needles" extends throughout the body. Sore eyes appear to be one of the serious symptoms of the poisoning, and in the case of the European woman who was bitten at Fiji, this was the last to disappear. Dr. A. H. Hallen, who described her case in the Government Medical Officer's Report, Levuka, June, 1901, states that natives declare that recovery from shellfish poisoning is often complicated by sore eyes. Possibly the state of health of the victim at the time of an attack would either help or hinder his recovery. The Queensland victim complained of failing eyesight an hour or so after he was bitten. He became drowsy, as in snake-bite poisoning, and later fell into a coma, from which he did not recover.

There has, to my knowledge, been no literature published on the proper treatment for this poison. As a case, with unfortunately fatal results, is reported to have occurred in Australia, there is ample opportunity for a medical man, interested in this branch of his science, to investigate the poison of cone shellfish and its treatment.

[1] Since this article was written the species responsible for the attack has been identified as *Conus geographus*. The actual specimen is now in the Queensland Museum.

Reports of Cases.

ACIDOSIS OCCURRING IN A PATIENT WHILE UNDER TREATMENT BY SIPPY'S DIET.

By C. T. Piper,
Bute, South Australia.

Clinical History.

A man, aged fifty-nine years, was operated on on June 16, 1934, for perforation of a juxtapyloric ulcer which had been present for eight hours. The usual conditions were present: a large radiating scar with central punched-out perforation, abundant fluid in the right side of the peritoneal cavity, with adhesive omental peritonitis. There was little other peritoneal reaction. The appendix was first explored and removed, the ulcer was sutured, and drainage was instituted through the right flank, as well as through the operative incisions. The patient's condition was good both before and after operation.

Convalescence was uneventful for one week, the regimen being as follows: nothing was given by mouth for twenty-four hours, after which sips of sweetened water were given, reinforced by saline solution with glucose given by the rectum. The bowels acted naturally in response to the saline injections on the third day. After this, weak Benger's food, sweetened with glucose, was given for one day. On June 20 the Sippy regimen was instituted, alternating alkaline powders with 90 cubic centimetres (three ounces) of milk and cream at hourly intervals throughout the day, and at two-hourly intervals throughout the night. The powders consisted of 0·6 gramme (ten grains) each of bismuth carbonate, precipitated calcium carbonate, bicarbonate of soda and heavy calcined magnesia.

At this time there was a pyrexia varying from 36·9° to 37·8° C. (98·4° to 100° F.), and the pulse rate ranged from 92 to 96. No collection could be discovered, and the patient was very comfortable. The bowels were acting normally; there was no abdominal distension or pain.

At 6 a.m. on June 23 temperature was 37·3° C. (99·2° F.) and pulse 88. The patient had had a good night, having had 0·2 gramme (three grains) of "Luminal" at 11.15 p.m. At 10 a.m. the temperature was 37·3° C. (99·2° F.) and the pulse rate had risen to 100. He was flushed and complained of not feeling quite so well—"a bit headachy". The respiration was a little increased. No sign of pulmonary disease could be found, and the nurse remarked that she could smell acetone in his breath. At 3.15 p.m. the patient had a profuse sweat. At 7 p.m. the temperature was 37·3° C.

(99·2° F.), the pulse rate was 120, and the respiratory rate had risen to 26. He was highly flushed and very drowsy; there was not only increased respiratory rate, but a very considerably increased respiratory tide. The pulse was soft and, for its rate, full. There was a very definite smell of acetone, and the tongue had the characteristic red dryness of acidosis. The urine gave a strongly positive Gerhardt test for diacetic acid. There was no sugar.

At 7.30 p.m. an intravenous injection of 50 cubic centimetres of 50% glucose was given, the patient was ordered to have copious fluids, all with glucose, and dry biscuits with jam if desired. Powders were given every three hours.

At 10 p.m. the temperature was 38·2° C. (100·8° F.), the pulse rate was 126 and the respiratory rate 28; at 2 a.m. the readings were 37·1° C. (98·8° F.), 120 and 24; at 7 a.m. they were 36·9° C. (98·4° F.), 116 and 24.

Urine passed at 10.30 p.m. was not tested, but a specimen passed at 7 a.m. was acid, and Gerhardt's test gave no reaction.

In the morning at 9 a.m. when I saw him he was feeling much better. There was still slight dyspnœa, the pulse rate was 96, and the respirations numbered 24 per minute. He was ordered a diet rich in carbohydrate, and to continue with the powders every two hours. There was no recurrence of the acidæmic condition, although the slight pyrexia continued, and was evidently due to the condition which determined the fatal event on the night of June 29, when the patient, who had at this time been feeling exceptionally well, suddenly collapsed and died in a manner which had all the appearance of being due to a massive pulmonary embolism.

There was no sugar present in the urine before operation or at any subsequent testing; nor had it been present on any other occasion on which I had examined the urine during four years association as doctor and patient.

Discussion.

This complication appears to have been a case of acidosis. It has been suggested to me that the condition was one of alkalosis due to excessive administration of alkalis, a condition well known to occur under treatment by the Sippy *régime*, and one of the reasons for adopting the newer treatment by tribasic phosphate, and which may give rise to ketonuria through a secondary disturbance of the fat metabolism. This may have been so, but the emergency was clinically an acidosis, and responded to intensive carbohydrate treatment in the same way as do the acidoses of such toxic conditions as influenza and pneumonia, and, with the aid of insulin, of *diabetes mellitus* itself.

Against the theory of primary alkalosis is the absence of premonitory symptoms. Up to the very eve of the acute attack the patient had been feeling extremely well, bright, cheerful and hungry. In fact I have rarely seen a patient after operation feel so well. His subjective state had been one of continual well-being from the day after the operation. There was none of the depression, apathy or anorexia which characterizes the early periods of alkalosis. Furthermore, the alkaline powders, of which only the soda and the magnesia are likely to produce alkalæmia, had been administered for only three days, in doses of 12 grammes (three drachms) of each daily. It is difficult to believe that this dosage would produce an alkalosis in a robust man.

It is my belief that he suffered at the time from a depletion of his sugar reserves under the strain of operation and subsequent starvation, and that the surplus fat in the milk-cream mixture was sufficient to determine an acidosis similar to that occurring in other febrile states. He had been mildly febrile up to that time.

I have never heard it mentioned, but it is perfectly obvious to anyone who has treated a diabetic that the Sippy diet is a badly balanced one in its early stages, and powerfully ketogenic. And were it not for the associated administration of alkalis, it is possible that cases similar to this one would be frequent. At the time of his attack the patient was having 900 cubic centimetres (30 ounces) of a mixture of equal parts of fresh milk and cream per day, and abundant water besides. He had refused to take sweetened drinks for three days previous to the event; this because he felt all right and did not like sweet things.

According to Lawrence the constitution of milk is three and a half ounces = protein 3·5 grammes, carbohydrate 5·0 grammes, fat 3·5 grammes; and one ounce of cream = fat 5·0 grammes and carbohydrate 0·25 gramme.

The diet then is:

	Protein.	Carbohydrate.	Fat.
Milk, 15 ounces ..	15	22	15
Cream, 15 ounces ..	0	4	75
Totals	15	26	90

Caloric value = 974.

Applying the formula $\frac{2C+P}{F} = 1$, we find that $\frac{2C+P}{F}$ in this case $= \frac{90}{60} = \frac{3}{2}$. That is, there is an excess of ketogen in proportion of 1·5 to 1, which is the ratio suggested for various ketogenic diets including that for the treatment of epilepsy; and the obvious inference from this is that it may be used as a simple and not unpalatable diet in those cases in which ketosis is regarded as being a desirable state.

The case is reported on account of the unusual nature of the complication and on account of the satisfactory response to intensive carbohydrate treatment. It is possible that the phlebitis which caused death a week later had something to do with the incidence of the attack. There may have been a pancreatic phlebitis causing an insulin deficiency, but there was no glycosuria. There may even have been a small pulmonary embolism to cause the rise in temperature, pulse and respiration rate, and I may have missed it. But there was no cough or hæmoptysis, and it would not account for the acidosis which was undoubtedly present. No *post mortem* examination was made.

A further lesson which this case brought home to me, and which others equally with myself may have forgotten, is the possibility of a deep phlebitis as a cause of a mild pyrexia in the post-operative as in the puerperal period. It is in remembering such a possibility that the prevention of disaster lies; although in this cause the patient had not been allowed to get up before the disaster occurred.

Acknowledgement.

I wish to acknowledge with thanks the assistance and criticism of Dr. Guy Lendon in the preparation of this case report.

Reviews.

HYGIENE FOR NURSES.

"HYGIENE FOR NURSES", by Guy and Linklater, is a compact and simply written little book which presents the elementary principles of hygiene in an attractive manner.[1] The division of the book into two parts separates the individual from the communal aspect of the subject. The former, being of more immediate concern to the nurse, is dealt with more fully. Such subjects as sewerage and water supply are considered as of less importance; the information supplied, however, is adequate. Part I deals with personal hygiene, the hygiene of pregnancy, lactation, and of infancy, food and metabolism, parasites and communicable diseases; Part II with the house, air and ventilation, lighting, heating, water supply and sewage disposal.

The authors are examiners to the General Nursing Council of Scotland and have modelled their book on the syllabus issued by that body. To the student nurse it may be recommended as indispensable and adequate.

[1] "Hygiene for Nurses", by John Guy, M.D., D.P.H., F.R.C.P., and G. J. I. Linklater, O.B.E., M.D., D.P.H., D.T.M. and H., M.R.C.P.; Third Edition; 1935. Edinburgh: E. and S. Livingstone. Crown 8vo., pp. 211. Price: 5s. net.

The Medical Journal of Australia

SATURDAY, OCTOBER 19, 1935.

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THE FEDERAL COUNCIL AND THE PARENT BODY.

Those who have followed in this journal the reports of the meetings of the Federal Council of the British Medical Association in Australia will know that for some considerable time the Council has been concerned with financial difficulties. The *per capita* payment received by the Council from the Branches is small in comparison with the important work that the Council has to do. The Council has realized that as time passes its activities must extend—that it must be prepared to deal for the whole of Australia in such matters as hospital practice and national insurance—and that extended activity will call for additional expenditure. The Council has not wished to call on the Branches for increased payments, particularly in view of the opinion expressed in several centres that the *per capita* payment by each Branch to the Parent Body was too high and that subscriptions should be reduced. It will be remembered that when the President and the Vice-President of the Federal Council, Sir Henry Newland and Dr. J. Newman Morris, visited England in connexion with the Centenary Meeting of the Association, they had conversations with the Council of the Parent Body regarding finance (see The Medical Journal of Australia, March 25, 1933, page 383). The Home Council was entirely sympathetic to the views expressed by Sir Henry Newland and Dr. Newman Morris; and later it was resolved that the whole question of finance should be discussed with certain other matters at a conference between officials of the Parent Body and the Federal Council at the time of the annual meeting of the Association in Melbourne in September, 1935.

This conference was held at the Medical Society Hall, East Melbourne, on the morning of September 10, 1935. Dr. E. Kaye Le Fleming, the Chairman of Council, occupied the chair, and he had with him Dr. H. S. Souttar, Chairman of the Representative Body, Dr. N. Bishop Harman, Treasurer of the Association, Dr. G. C. Anderson, Medical Secretary, Mr. L. Ferris Scott, Financial Secretary and Business Manager, and Dr. H. Guy Dain, Deputy Chairman of the Representative Body. All six Australian Branches were fully represented. It was an historic occasion, and one of the utmost significance. The proceedings were marked by understanding, sincerity and goodwill. The pity was that every member of the six Australian Branches could not be there to feel the sympathetic atmosphere that was at once created. Two questions were brought up for discussion. The first had to do with the regulations pertaining to the formation within the Association of sections for the study of special subjects. Sir Henry Newland, speaking for the Federal Council, voiced the fears of the Council that the multiplication in Australia of scientific bodies outside the ambit of the Association might be a cause of weakness to it. He pointed out that according to the rules of the Association any member of the Association had a right to join any section that might be formed in the area of the Branch to which he belonged. It was felt, he said, that those who banded themselves together to study a particular branch of medicine, and whose interests lay entirely in that subject, should have the right to elect members of their section. Provision had

been made in England for the definition of specialists; and he thought that some such arrangement might possibly be made in Australia if the rules of the Association regarding the formation of sections were altered. Already the present rule had led to the formation outside the Association of at least one organization which would have remained within its ambit had the rule not been in existence. After general discussion Dr. Le Fleming said that he had no doubt that the Home Council would understand the position. Conditions in Australia and in the Old Country were different. To alter the rule would necessitate an alteration in the constitution of the Association, but constitutions were not unalterable. He said that he felt sure the Parent Body would move in the direction desired by the Federal Council.

When financial matters came up for discussion the same spirit of helpfulness was manifest. It became clear at once that the Home Association was not receiving so large an amount of money as many members of the Australian Branches thought, for the loss by exchange rates was being borne by the Parent Body. Further, the receipt of *The British Medical Journal* by every member of the Association was such an integral part of the constitution of the Association and the journal was such a valuable binding link between the widely scattered Branches that any alteration in the present journal arrangements was out of the question. Dr. N. Bishop Harman, however, speaking as Treasurer, said that the funds of the Association were the funds of the whole body and not of the Parent Body only; the Association was a mutual aid society, and when one of its parts required help, that help had to be forthcoming. The Association had faced similar positions before and would not hesitate to do what might be necessary as far as the Federal Council in Australia was concerned. Obviously no definite promises could be given and no definite plan could be laid down, but when the meeting closed there was an understanding that the Council of the Parent Body would take some steps to strengthen the hands of the Federal Council, to make it more efficient as a driving force and a more intimate bond of union between the Association in England and the Branches in Australia. We have no hesitation in declaring that in the future this conference will be regarded as marking the beginning of a great forward movement in the history of the British Medical Association in Australia.

Current Comment.

THE VISCEROGALVANIC REACTION.

One of the prime difficulties of the clinician is that his conclusions cannot always be based on objective phenomena. Quite apart from a consideration of the patient's history, due notice must be taken of the various subjective symptoms complained of, though it is far from easy to assess these at their true value. A good illustration of this may be seen in the examination of the nervous system; it is comparatively easy to record the results of testing the motor functions, but the sensory mechanism is much more difficult to examine accurately. Pain, and in particular referred pain, is of special importance. It is a subjective expression of a morbid state that does not give rise to objective phenomena of corresponding intensity or reliability. Thus it is known that skin reflexes occur, such as those associated with vasomotor and pilomotor disturbances, but these are not easy to demonstrate. Hypertonicity of muscles, causing, for instance, the well known "guarding" of the appropriate segments of the abdominal wall in intraabdominal inflammatory disease is another most useful sign. There is no doubt that the corresponding segments of the spinal cord must be in a state of hyperexcitability.

E. A. Speigel and M. G. Wohl have recently adduced further evidence of this and have also evolved a method which may be used clinically.[1] They have made use of the fact that it is simple to measure changes of the electric potential of the skin, and believe that such changes may be associated with increased excitation of the segmental centres of the cord. Psychic excitation produces similar changes through disturbance of the vegetative centres, as the use of the psychogalvanometer shows. Speigel and Wohl have used the familiar method in which a known variable potential is opposed to the unknown skin potential, with a sensitive galvanometer in circuit. Non-polarizable electrodes were employed, arranged so as to press as lightly as possible on the skin. An adequate series of control patients insured stability of the results, and 32 other patients were tested who were suffering from various forms of visceral disease, such as peptic ulcer, cholecystitis, coronary occlusion and nephrolithiasis. In twenty-five of these subjects zones of hyperalgesia were discovered, and by using this viscerogalvanic reaction corresponding zones of increased potential were demonstrated. The latter zones were found to be larger

[1] *Archives of Internal Medicine*, August, 1935.

in extent than those in which hypersensitiveness could be found by ordinary means; this would be expected. The authors point out that the cause of the phenomenon of altered potential is probably variations in activity of the sweat glands, though possibly there may be in addition some other alteration in the epidermal cells. This appears to be the cause of the psychogalvanic reaction also, but here we are dealing with a reaction which is only transient, though it affects the whole body. The viscerogalvanic reaction, on the other hand, affects only certain zones of the body and appears to be a continuous phenomenon maintained by sustained impulses from the internal site of disease. It does not seem likely that this refined method will come into clinical use, but it might be of distinct value as a means of investigating internal disease.

TREATMENT OF MYASTHENIA GRAVIS.

A few years ago it could not be said that any known treatment was of avail in the disease known as *myasthenia gravis*. A host of remedies had been suggested and tried. Iron preparations were given in large doses, combined with strychnine in small doses; and the inevitable arsenic was often thrown in for good measure. Faradism, galvanism, massage, glandular extracts, Röntgen rays, intravenous injections of thorium-X and a "warm, equable climate" were employed together or separately. They effected precisely nothing. And the physician always portentously advised his myasthenic patient to rest. That was easy; myasthenic patients often enough cannot walk, raise their heads or open their eyes.

In 1930 the name of Dr. Harriet Edgeworth appeared over an article in an American medical journal. Dr. Edgeworth herself was afflicted with *myasthenia gravis* and wrote a lucid account of her sufferings. By some means she was led to test the effect upon the disease of ephedrine, taken by the mouth. The improvement was immediate and astonishing. Said Edgeworth: "How ephedrine produces a continuous improvement in some patients is unknown. The daily ingestion of it over a period of three years has changed me from a totally helpless, bedridden person to my present condition, where I live a comparatively comfortable and pleasant life of some usefulness." Later, McAlpine announced similar successes following the use of ephedrine in half-grain doses, given thrice daily.

During this period arose the fashion for combining the ephedrine with glycine, or of using glycine alone. This substance, of which the full name is amino-acetic acid, needs to be carefully distinguished from glycin (para-hydroxy-phenyl amino-acetic acid), a photographic developer with toxic properties. It is worthy of note that the glycine content of household gelatine is 25%. Edgeworth found that glycine was useless in the treatment of her own case, but willingly admitted its beneficial influence on many patients, as reported by Schmitt and others.

Some observers have assumed that the easily produced fatigue of voluntary muscle, so salient a feature of myasthenia, is caused by a curare-like poison. This substance is presumed to exert its effects at the myo-neural junctions. It would seem logical, therefore, to test the influence upon the disease of curare's partial antidote, physostigmine. Working on these lines, M. B. Walker last year reported instances of striking improvement following hypodermic injections of physostigmine salicylate (one-fiftieth of a grain) and of its analogue, prostigmin. The good effect is held to be due to the fact that these drugs delay or prevent the destruction of acetyl choline by choline esterase in the motor nerve endings.

L. P. E. Laurent and W. W. Walther[1] have lately prosecuted researches in the treatment of *myasthenia gravis* with large doses of potassium chloride. Their work had its origin in a discovery made by Feldburg and Vartianen during 1934. These workers showed that potassium chloride solutions stimulate the cells in the superior cervical ganglion of the cat and will raise the excitability of those cells to pre-ganglionic stimuli and to acetyl choline. This use of potassium ions was found to double the response to stimuli of the ganglion cells; further, it was determined that eserine solutions, perfused through the ganglion, lowered the threshold of stimulus to injections of acetyl choline as much as twentyfold. Although there seems to be no lowering of the potassium content of the blood plasma in myasthenia, Laurent and Walther observed both subjective and objective improvement in three patients treated with potassium chloride. Ptosis diminished, ocular movements increased, and there was an increase amounting to three to five pounds in grasping power. These results followed small doses (two grammes) given five times a day. One patient under observation took only single large daily doses of the potassium salt (twelve grammes in a tumbler of water). In her case the double ptosis vanished, the naso-labial folds reappeared, and the lips became mobile.

Although the favourable results following the use of potassium chloride seem on the whole to be less striking than those which follow injections of prostigmin and its congener, yet the potassium salt would seem to be of great aid, especially in abetting the action of prostigmin. Laurent and Walther arrived at this conclusion after treating six patients with the chloride for two months, sometimes using as much as 40 grammes of the drug per day. Such measures, of course, may be expected sometimes to result in mild attacks of diarrhœa, and always in copious diuresis. At present the use of potassium ions, of prostigmine, ephedrine or any other drug produces benefit which lasts only a few hours; the patient's lot can be improved only by repeated administrations. Yet, as much of the work on the subject is barely one year old, it is perhaps justifiable to entertain brighter hopes for the future.

[1] *The Lancet*, June 22, 1935.

Abstracts from Current Medical Literature.

MORBID ANATOMY.

Lesions from Staphylococcus Toxin.

R. H. Rigdon (*Archives of Pathology*, August, 1935) refers to the work of many authors on the lesions produced by staphylococcus toxin in laboratory animals. He states that many investigators consider the lesions in the tissues to be due to simple fractions in the staphylococcus toxin. He has injected dogs and rabbits with toxin prepared from a hæmolytic strain of *Staphylococcus aureus*. He found that hæmorrhage and necrosis were the characteristic lesions produced after intravenous injection. The type of lesion was influenced by the quantity of toxin and by the length of time elapsing between the time of injection and the time of death. The areas of necrosis were most frequently found in the kidneys and in the colon of the rabbit; the hæmorrhagic areas usually occurred in the gastro-intestinal tract and peritoneal cavity of the dog. The author concludes that the hæmorrhages are the result of the action of the toxin directly on the endothelium of the capillaries and small blood vessels, permitting the escape of red blood cells; the necrosis is the result of the toxin directly on the cells of the body.

Osteitis Fibrosa.

Hermon Taylor (*The British Journal of Surgery*, January, 1935) discusses the pathology of the osseous dystrophies from the point of view of calcium metabolism. He points out that calcium differs from other important metabolites, such as sugar and chloride ions, in that there is no concentration of it in the body, and deprivation of calcium results in a constant drain of it from the skeleton into the urine and fæces. The absorption of calcium may be hindered by excess of phosphates or carbonates in the diet, or by incomplete digestion or absorption of fats, which causes the precipitation of calcium soaps in the intestine, or by lack of vitamin *D*, or possibly by incomplete protein absorption from the gut. The excretion of calcium is also influenced by variations in the metabolism of other substances, the effects of which are reflected in the calcium content of the serum, such as the concentrations of protein and of phosphate in the serum and the amount of parathyreoid hormone present. In the experimental work phosphatase, which was prepared by Kay's method, was injected into rabbits and its effects were studied in order to determine the rôle of the high plasma phosphatase in decalcifying diseases. In spite of continued injections of the enzyme, the level of phosphatase in the plasma remained normal and there was no effect whatsoever on the bones. The author concluded that the increased plasma phosphatase was the result of the disease present and not the cause of it. He points out that bones undergoing prolonged decalcification, as in *osteitis fibrosa*, are on the one hand under the influence of the decalcifying agent and on the other under that of the response of the weakened bone whereby the osteoblasts are stimulated to form new bone by an increased output of phosphatase, which, however, is constantly being swept away into the circulation, causing a high concentration of the phosphatase in the plasma. This effect of the osteoblasts is well illustrated in the excess of osteoid material and in the areas of actual calcification in this material; and this explanation supports the observation that high plasma phosphatase is independent of the nature of the decalcifying agent. Many workers, including Leriche and Policard, Jones and Roberts, and others have observed decalcification in bone in the presence of hyperæmia. The author interprets this rather as a hindrance to recalcification by excessive removal of phosphatase resulting from the hyperæmia. He also advances the view that the stimulus to the formation of phosphatase by the osteoblasts is strain, and notes that the formation of bone in the mesenchyme in the length of the growing limbs of the fœtus—the line of continuous strain—also coincides with the appearance of phosphatase in this situation. He summarizes his theory of ossification as a response by the connective tissue cells to strain of continuous type by the formation of phosphatase, whereby bone is laid down in the matrix around cells which thus become typical osteoblasts. The calcifying power of the phosphatase in the osteoblast lies in the local concentration of its action as distinct from a diffuse increase which would merely cause a permanent slight shift in the calcium-phosphorus ratio in the tissues without any precipitation of solid salts. It is noted also that excess calcium is excreted by way of the fæces in the rabbit, whereas in man elimination is almost entirely by way of the urine and he mentions the views of various authors to the effect that the decalcifying action of parathormone in ordinary doses in man is the result of excessive phosphate excretion in the urine. The localized decalcification is accompanied by hæmorrhages into the marrow which are probably due to the effects of the hypercalcæmia on the body cells, this concentration of calcium being naturally greater in the blood of the capillary vessels at the actual site of decalcification, resulting in damage to the endothelium of the bone capillaries and extravasation of blood into the marrow. Repair takes place in the marrow by proliferation of connective tissue cells, the hæmopoietic elements being removed by phagocytosis, and at this stage the giant cells make their appearance. In metabolic decalcification too slow to cause damage to bone capillaries the histological picture is one of simple solution by lime salts with large spaces around the vessels but no osteoclasts. This conception of the function of the giant cells as a part of the cellular reaction to the hæmorrhage is in accordance with the view of Kolodny, Codman and Mallory, who suggest that the giant cells remain amongst the connective tissues and form the giant cell tumours of von Recklinghausen's disease or disappear and leave cysts. The author definitely considers that the hypercalcæmia is due to hyperparathyreoidism and to no other cause. The low serum phosphorus is an effect of ionic dissociation and is not specific to parathormone. The high plasma phosphatase is indicative of the reaction of the osteoblasts to the decalcification and is not specific. The excessive excretion of calcium in the urine, although not specific to hyperparathyreoidism, is strongly suggestive of it. The histological appearances are indicative of a powerful decalcifying agent.

Pseudotuberculoma Silicoticum.

Tissue reactions to silica and the silicates have been studied. Much of the work has been done in connexion with the inhalation of siliceous dusts. Siliceous dusts have been inoculated into laboratory animals, but only seldom does an opportunity arise of studying the cellular reaction to siliceous material which has been embedded in human subcutaneous tissue for some years. Shattock in 1916 described such a case, and two further cases have been described by J. S. Faulds (*The Journal of Pathology and Bacteriology*, July, 1935). In the author's two cases twenty-three years and ten years had elapsed between the infliction of an injury and the subsequent appearance of a tumour. Histologically these tumours consisted of a series of small tubercle-like nodules composed of centrally situated multinucleated giant cells, endothelial cells and lymphocytes, embedded in collagenous fibrous tissue. The giant cells had a peripheral ring of nuclei arranged in a horseshoe-shaped manner. Surrounding the giant cell systems was an area of lymphocytes and fibrous tissue, and in the deeper layers of the mass, where it involved the underlying muscle, the muscle fibres were seen to be infiltrated by small collections of lymphocytes with an occasional giant cell system. As the appearances suggested an actively spreading tuberculous process, sections were stained by the Ziehl-Neelsen method, but no tubercle bacilli were found. When sections were examined by polarized light, brilliant points of light were discovered throughout the whole field; these points of light were caused by doubly refracting crystals lying in the tissue. In one instance the results of analysis of slate from the tissue and of rock from the garden where the

accident occurred were identical. The author discusses the fate of silica embedded in body tissue. He points out that in the late stages polarized light alone can differentiate between a tuberculous and siliceous lesion. The presence of silica, of course, does not negative a dual cause for the lesion.

MORPHOLOGY.

The Cerebral Veins.

J. E. A. O'CONNELL (*Brain*, December, 1934) attempts to explain the course taken by the superior cortical veins of the cerebrum, and to determine whether there exists any constant relationship between the cortical veins and the sulci and gyri of the cerebral cortex. The fundamental plan is best seen in the fœtus, where the veins radiate from the region of the insula, but this condition persists in adult life. The superior veins approach the margin of the hemisphere at right angles, but their terminal portions mostly change direction before entering the sinus. The direction of the cortical veins of the cerebrum is determined by the growth of the hemispheres. As the result of the growth of the frontal lobe anteriorly, the terminal portions of the anterior veins run posteriorly before entering the sinus, and similarly, growth of the hemisphere posteriorly results in the posterior veins entering the sinus after bending anteriorly. The posterior inclination of the inferior veins, as they pass to the transverse sinus, has a similar explanation. One of the members of the superior cortical series of veins is found in each of the precentral, central and post-central sulci, and similarly a tributary of the superficial middle cerebral vein is found in each of the sulci which separate the opercula of the insula. The statement that at birth the *lacunæ laterales* are absent and later appear and grow *pari passu* with the arachnoid granulations is confirmed. Past middle age the *lacunæ laterales* are two in number, one being placed on each side of the superior sagittal sinus. The *lacunæ laterales* serve as lateral extensions of the lumen of the superior sagittal sinus over the superomedial margin of the cerebral hemisphere in the posterior frontal, parietal and sometimes also the anterior occipital regions, where the majority of the arachnoid granulations are found. The floor of each lacuna is everywhere carpeted by a layer of these granulations.

The Frontal Lobe in Man: Maximum Removals.

WILDER PENFIELD AND J. EVANS (*Brain*, March, 1935) describe three cases of radical removal of large portions of the frontal lobe, and find that if the precentral gyrus be left intact surprisingly little disturbance of function which can be detected by ordinary methods of examination is produced. There is no disturbance of the control of micturition, no forced grasping, no alteration of tone of the extremities or in the activity of deep or superficial reflexes. The removal of approximately the anterior half or two-fifths of the right frontal lobe was not associated with any alteration, neurological or psychological, that the authors could detect. After larger removal certain important defects were noticed. Neurologically each was normal. By the ordinary psychometric tests each would have to be judged normal, although neither would rank very high. Each patient was lacking in initiative. Each was very good-natured and cooperative, which may in some cases perhaps be evidence of lack of initiation of ideas. The authors also observe that in several cases not described in their paper relatives have reported that removals of very large areas of the frontal lobe have resulted in marked improvement in the patient's temper. Insight and capacity for introspection were preserved in the two cases described, also capacity to follow instruction was unimpaired, but initiative and capacity for planned action were clearly defective.

The Significance of the Lymphoid Nodule.

H. E. JORDAN (*The American Journal of Anatomy*, July, 1935) states that the significance of the lymphoid nodule appears to be the same at all phylogenic levels from fishes to mammals, whether in spleen, bone marrow or lymphoid nodes, namely, the production of polyvalent lymphocytes capable of differentiating into erythrocytes, monocytes, thrombocytes, granulocytes or megakaryocytes, depending upon environment factors. The typical lymph nodule ("follicle") has a germinal centre of large lymphocytes (lymphoblasts, hæmocytoblasts) enveloped by concentric layers of small lymphocytes (lymphoid hæmoblasts). Throughout the nodule occur also lymphocytes of intermediate size, representing transitional stages in the growth of small to larger lymphocytes. Only the large and medium sized lymphocytes proliferate; the small lymphocytes are both the offspring and the ancestors of the larger lymphocytes. The various sizes represent morphological modifications of the one and the same cell. At the periphery of the nodule the small lymphocytes may pass into adjacent sinuses, venous in the spleen and marrow, lymphatic in the lymph nodes. The spleen of the lung-fish combines the equivalents of the three separate hæmocytopoietic tissues of mammals: splenic, lymphoid and myeloid. At the level of the amphibians, bone marrow assumes minor transitory erythrocytopoietic activity. At the level of mammals the original threefold function of the spleen becomes apportioned among "vestigial" spleen, lymphoid nodes and marrow. The spleen of mammals remains active as a source of lymphocytes and monocytes, the lymph nodes are the chief locus of lymphocyte production, and the erythrocytopoietic process is normally restricted in post-fœtal stages to the bone marrow, but during early fœtal life and in certain anæmic and leuchæmic conditions the spleen functions also as a considerable source of erythrocytes. In the main, in these conditions, they enter the blood stream as small lymphocytes, possibly to be removed in the marrow to serve as red cell ancestors. The lymphoid nodules of the bone marrow of mammals have the typical structure of such nodules in spleen and lymph nodes. The small lymphocytes pass from the nodules and grow into larger lymphocytes, some of which get into adjacent venous sinuses, where they differentiate into erythrocytes. Extravascular differentiation of larger lymphocytes results in the production of granulocytes. The original ancestor of both the erythrocytes and granulocytes is the hæmocytoblast, derivative of the stroma reticulum. The lymphoblasts of lymph nodes and the spleen, and the myeloblasts of bone marrow are identical cells as regards essential structure and developmental potency. They are hæmocytoblasts located in different tissues; they have identical multiple developmental capacities, the specific result depending upon the specific stimulus of differential environmental factors. The small lymphocyte is a daughter cell of the hæmocytoblast and maintains the capacity for variable differentiation inherent in the mother hæmocytoblast. The triple source of hæmocytoblasts, namely, in the spleen, lymph nodes and bone marrow, provides a blood-forming mechanism with multiple "factors of safety". Circulating lymphocytes may leave the blood or lymph stream on local demand to serve as ancestors of monocytes, macrophages, granuloblasts or erythroblasts. Lymphocytes are the circulatory equivalents, as regards potential ancestors for monocytes, erythrocytes and granulocytes, of the fixed reticulo-endothelial system.

Innervation of the Thyreoid Gland.

JOSE F. NONIDEZ (*The American Journal of Anatomy*, July, 1935) gives an account of the innervation of the thyreoid gland in the dog. The larger nerve trunks carry thick and medium sized myelinated fibres and also unmyelinated fibres. There are true ganglia in some thyreoids, but the neurones scattered in the parenchyma are regarded as sensory ganglion cells which have migrated from the *ganglion nodosum* of the vagus along the superior laryngeal nerve. Terminations on the follicular cells are absent, and most of the cells of the follicles are not even in contact with the nerve fibres of the plexus. The nerves, both sensory and autonomic, are for the control of the blood supply and may indirectly influence the rate of secretion and the removal of the hormone produced by the gland.

British Medical Association News.

SCIENTIFIC.

A meeting of the Victorian Branch of the British Medical Association was held at the Medical Society Hall, East Melbourne, on February 6, 1935, Dr. R. M. Downes, the President, in the chair.

Fractures of the Neck of the Femur.

Dr. Thomas King read a paper entitled "Treatment of Fractures of the Neck of the Femur by Extraarticular Osteosynthesis" (see page 521). He illustrated his remarks by lantern slides and cinematograph films.

Dr. Leo Doyle said that there was not much for him to say. He congratulated Dr. King on his presentation of the method, and he could see no flaw in his argument.

The outstanding feature of Dr. King's attitude was his criticism of the Whitman method of reduction. Dr. Doyle said that all medical students were taught this method, but his own experience of it had not been very satisfactory. There were many objections to it, one being the very extensive plaster from foot to chest, which some patients would not stand and some could not. Dr. Doyle considered that Dr. King's method was superior to the open operation. He had seen him do this operation several times, and it was not a simple method by any means. It involved a difficult technique, much time, and much patience. The difficulties were: first, to get the portions of the fractured bone into a correct position; secondly, the guiding wire, and, thirdly, the nail into correct positions.

Dr. Doyle criticized Dr. King's advocacy of allowing the patients to walk about early, even as early as the sixth week. He thought that Dr. King would find by experience that this was too soon, as there was some shearing strain on the neck of the femur, with a tendency to the production of *coxa vara*. One other word of advice Dr. Doyle had to offer, and that was that the use of "Pantocain" as a spinal anæsthetic, prepared with mucilage, spirits and water, was not devoid of danger. All these substances could not be fixed at once by the nervous system, and there was a danger of fatal results if the patient was allowed to sit up too soon.

Dr. Gordon Shaw said that all must be impressed by the large amount of work and thought which Dr. King had given to a difficult subject, and also to his excellent method of presentation. The actual diagnosis of fractures of the neck of the femur was not always so easy or so certain as might be thought. A fracture could even be overlooked after X ray examination and discovered later by the occurrence of deformity. Secondly, impacted fracture could not be relied upon to remain impacted, nor could impaction shown by X rays be trusted to be a true impaction in a surgical sense. Dr. Shaw had seen a patient who had developed two and a half inches of shortening on the side of the fractured neck of the femur when the fracture originally had been overlooked on X ray examination.

In literature on the subject the percentage of cases in which bony union was achieved by ordinary methods varied between 5% and 78%, the average being about 50% by methods of treatment before the Smith-Petersen nail was introduced. As regards method, Dr. Shaw considered that the Smith-Petersen nail was probably the method of choice under ideal conditions. It required expert surgical skill, a properly equipped fracture table, special X ray appliances, and expert X ray operators, and this method should not be used unless all these requirements could be supplied. Spinal anæsthesia was the anæsthetic of choice. In any method the important point was the reduction by internal rotation and forward movement of the femur. The checking of the reduction under direct X ray observation involved a special apparatus and a specially trained team. His criticism of Dr. King's method was that he considered that multiple X ray photographs were cumbersome. They might be necessary, but the method would be improved if the multiplicity could be reduced. With regard to after treatment, Dr. Shaw said that the patient should not be allowed to walk about until bony union occurred, and this period he considered was at least eight weeks. In any less time the nail was bound to work loose with the strain of walking. Plaster, if applied under spinal anæsthesia after good reduction of the fracture, would give good results in most cases. If bony union was not good within three months, non-union must be accepted. Dr. Shaw said that he had no personal experience of the use of the Smith-Petersen nail in the treatment of cases of non-union, but had considerable experience of the use of the bone peg with success in the majority of these cases. In any case it was a serious operation. He congratulated Dr. King on his excellent presentation of an interesting method.

Dr. J. B. Colquhoun expressed appreciation of the lecture and considered that Dr. King's method was an illustration of the need for the employment of specialists in the treatment of certain forms of injury and disease. The statistics of the occurrence of union and non-union in cases of fractured neck of the femur in the hands of British orthopædic surgeons gave the figure for bony union with plaster methods as 30%; for American orthopædic surgeons the figure was given as 24%. Dr. King and others claimed 70% of union by his method, so it was evident that this must be the method of choice in the future. Dr. Colquhoun said that he had been assistant to Smith-Petersen in his earlier days, when open operation was employed, and even in patients aged between sixty and eighty-five there was conspicuous absence of shock. It seemed to him that the use of the nail by the open method under direct vision, as employed by Smith-Petersen, had a good deal to recommend it. The operation took only about an hour, and he thought that the combination of the open method and Dr. King's method, with X ray control, might be an improvement on Dr. King's closed method. The essential feature of the operation, in Dr. Colquhoun's opinion, was not the nail, but the accurate reduction of the fracture and impaction of the fragments, as was suggested by Cotton many years ago.

Dr. Keith Hallam referred to the estimation of bony union by X rays and the consequent decision as to the time for walking. He said that in fractures of the radius or ulna in children, firm bony union occurred in from twelve to fourteen days, but in elderly people, especially in fractures of the neck of the femur, union might take many months, and X rays would show the fracture line still apparent. In some such cases an opinion based on X ray examination was practically valueless, and X ray photographs could not indicate in every case when fractures had united.

Dr. John Kennedy congratulated the lecturer on his extraordinary patience and perseverance. He said he was sure that Dr. King's method represented an advance on previous methods. He himself had tried the closed method with X ray control, but had reverted to the open method. Regarding the time at which bony union occurred, he had allowed patients to walk as early as three months, and in some such cases the fractures had given way. It took many months for firm union to take place.

In closing the discussion, Dr. Rupert Downes said that he was filled with admiration for the ingenuity, industry and enthusiasm which had actuated Dr. King's work, and he expressed the thanks and congratulations of the Branch for the clear presentation of the method.

Dr. King, in reply to Dr. Doyle, said that he had not been able to think of a simpler method and he had been forced to abandon attempts to simplify his method as shown. Regarding the time for allowing the patient to walk, he did not feel sure what was the earliest safe period, but he was satisfied that when in doubt the patient should not be allowed to walk. Probably the earliest time was about eight weeks after operation, and it was necessary to use discretion, having regard to the weight of the patient and the density of bone formation as revealed by X rays. He agreed with Dr. Shaw in his remarks about impacted fractures. In regard to Dr. Hallam's opinion that X ray pictures were seldom reliable

in estimating bony union, a lateral view of the hip joint would show callus formation frequently when the antero-posterior view was inconclusive. Referring to Whitman's method, Dr. King said that the nail was obviously better than treatment by plaster cast alone, but the results of plaster in Whitman's own hands were said to be good. In conclusion, Dr. King said that he could not have carried out the work without the help of all his colleagues in Saint Vincent's Hospital; especially was he grateful to Dr. Leo Doyle, who had encouraged him to persist with this idea when he had discussed it with him. He was also specially grateful to Dr. C. G. Shaw.

Public Health.

THE INTERNATIONAL PACIFIC HEALTH CONFERENCE.

The second International Pacific Health Conference, convened by the Commonwealth Government, met from September 3 to 6, 1935, at the School of Public Health and Tropical Medicine, Sydney. The holding of the conference at this school was specially fitting, since the school was erected and equipped by the Commonwealth Government and staffed by the Commonwealth Department of Health as one major outcome of the first International Pacific Health Conference, which met at Melbourne in December, 1926.

The following were the official delegates and the countries and territories represented at the conference:

League of Nations: Dr. C. L. Park, Director of the Eastern Bureau, Health Organization, Singapore.

Great Britain: United Kingdom, Fiji, Dr. A. H. B. Pearce, Chief Medical Officer, Fiji, and Central Medical Authority, Western Pacific; Straits Settlements and Federated Malay States, Dr. G. A. Ryrie, Medical Superintendent, Federal Leper Settlements, Sungei Buloh, Federated Malay States; Western Pacific, Dr. H. B. Hetherington, Senior Medical Officer, British Solomon Islands Protectorate; Gilbert and Ellice Lslands, Dr. F. E. Montague, Senior Medical Officer.

China: Dr. Wu Lien Teh, Director of the National Quarantine Service.

Japan: Dr. Genzo Katoh, Medical Officer, Ministry of the Interior.

Netherlands: Netherlands East Indies, Dr. H. de Rook, Inspector of Public Health, Macassar.

New Zealand: Dominion and Dependencies, Dr. M. H. Watt, Director-General of Health; Western Samoa, Dr. P. J. Monaghan, Principal Medical Officer.

Australia: Commonwealth, Nauru, Dr. J. H. L. Cumpston, Director-General of Health; Papua, Dr. W. M. Strong, Chief Medical Officer; New Guinea, Dr. E. T. Brennan, Director of Public Health; Norfolk Island, Dr. L. S. Duke, Government Medical Officer; Northern Territory, Dr. C. E. Cook, Chief Medical Officer; Queensland, Sir Rahpael Cilento, Director-General of Health and Medical Services; New South Wales, Dr. E. S. Morris, Director-General of Public Health.

There also attended and took part in the conference thirteen officers of the Commonwealth Department of Health and of the services in New Guinea and Papua, as follows:

Commonwealth Department of Health: School of Public Health and Tropical Medicine, Sydney, Professor Harvey Sutton (Director), Dr. A. H. Baldwin, Dr. F. W. Clements, Dr. G. A. M. Heydon, Dr. W. C. Sawers and Mr. F. H. Taylor; Administrative Staff, Dr. A. J. Metcalfe (Sydney), Dr. P. W. Mitchell (Brisbane), and Dr. F. McCallum (Canberra); Commonwealth Health Laboratories, Dr. T. J. P. Cotter (Townsville).

Department of Public Health, Mandated Territory of New Guinea: Dr. C. M. Deland and Dr. Bruce Sinclair.

Medical Service, Territory of Papua: Native Medical Assistant, Lahui Ako.

The conference was opened on the forenoon of September 3 by the Honourable Sir Charles Marr, M.P., who was the Commonwealth Minister for Health at the time when the official invitations to the conference were transmitted to other countries and territories. The Minister for Health (the Right Honourable W. M. Hughes, K.C.) was unable to be present on the occasion of the official opening, but later met the delegates and presided at an official dinner on the evening of September 5.

Dr. J. H. L. Cumpston presided throughout the conference, and Dr. F. McCallum, of the Commonwealth Department of Health, acted as Secretary. In his presidential address, Dr. Cumpston recalled the International Plague Conference held at Mukden in 1911, which was the first official international medical conference to be held amongst the Pacific countries and which had as president the distinguished Dr. Wu Lien Teh, who was now visiting Australia for the first time as the delegate for China at this Pacific Health Conference. Dr. Cumpston announced that wishes for the success of the conference and regret that no representative could attend had been received from the Governments of France, United States of America, Canada, Portugal, whilst he had received personal letters from colleagues in the health services of each of these countries, expressing their interest in the objects of the conference. The Far Eastern Association of Tropical Medicine, through its Vice-President in Australia (Sir Raphael Cilento), also sent fraternal greetings to the conference.

The programme of the conference was so arranged that general discussion followed papers from delegates who had special experience in some phase of the subject under consideration. The outline of the programme was as follows: (i) Review of action taken and results achieved, to further the objects of the resolutions adopted by the first International Pacific Health Conference of 1926. (ii) Diseases of special importance in the Zone. (iii) Diet in relation to climate, race, work, health and survival. (iv) Features of health and medical services under the varying conditions of administration which exist in the Zone. (v) Native medical education under the varying conditions of social development *et cetera* which exist in the Zone. (vi) Prospects of profitable cooperation within the Zone, with special reference to coordinated research and correlation of information (including the quarantine aspects—maritime and air).

Review of Progress Since 1926.

The first conference of 1926 agreed upon a series of resolutions with reference to: (i) intelligence service, (ii) quarantine cooperation and (iii) research in a proposed Austral-Pacific Zone "situated south of the equator and between longitude 140° east and 140° west". (This geographical Zone extended approximately from the Queensland-Northern Territory border eastwards to the Tahiti group.) It was pointed out that within this Zone an epidemiological intelligence service had been maintained since 1926. The Commonwealth Department of Health had received and circulated in this Zone information relating to the current course of disease, urgently by cable and wireless when the necessity arose, and regularly in weekly, quarterly and annual summarized records. This service had linked up with the work of the Eastern Bureau of the Health Organization of the League of Nations at Singapore, which functioned as a "regional bureau" for the collection and transmission of advice regarding disease notifiable to the *Office International d'Hygiène publique* at Paris under the terms of the International Sanitary Convention of 1926. No occasion had arisen in this period for notification from the Austral-Pacific Zone of cases of the diseases dealt with by this Convention (plague, cholera, yellow fever, epidemic typhus and epidemic smallpox). Within the Zone itself, however, other diseases were of special importance and there had been a free exchange of information relating to the current course and prevalence of epidemic influenza, dysentery, measles, poliomyelitis *et cetera*.

With regard to quarantine cooperation, the more standardized procedure proposed by the conference of 1926 had not been adopted in its entirety. Fiji had followed

the suggested schedule in a revised quarantine ordinance of 1929 and the Commonwealth and the territories under its administration had an established uniform procedure and a working relationship with New Zealand. Generally throughout the zone a very cordial spirit of cooperation had been developed between administrations responsible for port health work and quarantine.

The general advancement of research and of coordinated investigations recommended by the Conference of 1926 had not been possible of achievement in the circumstances which had existed since 1926. None the less, within limitations of budgets and staff, many of the administrations in the Zone had carried out much useful investigational work. In Australia the School of Public Health and Tropical Medicine had actively cooperated with the local administrations in Queensland, the Northern Territory, Papua and New Guinea. In the western Pacific island groups, the Rockefeller Foundation had assisted in several surveys and investigations. Within their own territories especially good work had been done in Fiji and in Nauru, and by the laboratory at Rabaul and the Gaston Bourret Laboratory in Noumea, amongst others. A beginning in coordinated inquiry had been made with the dispatch of the Hermant-Cilento mission of 1928-1929 to the island groups of the western Pacific, under the ægis of the Health Organization of the League of Nations. This mission, in a valuable report, had proposed certain matters for concerted action, including an entomological survey in the western Pacific, with special reference to the distribution and prevalence of malaria and filariasis in that area. This proposal had been sympathetically considered by the Health Organization of the League of Nations, but circumstances had prevented any practical action to initiate this survey.

Special Diseases of the Zone.

The general and special disease picture of the Zone and of neighbouring countries was reviewed in the light of the experience of delegates from each territory. As an introduction to more specialized papers, Dr. C. L. Park, Director of the Eastern Bureau at Singapore, presented to the conference a valuable survey of disease in the Eastern Zone, tracing the recent distribution and prevalence of plague, cholera, smallpox, typhus, leprosy and malaria throughout the East, and commenting on salient features of the epidemiology of these diseases.

Dr. F. McCallum, of the Commonwealth Department of Health, reviewed the special disease picture of the Austral-Pacific Zone, reporting its freedom from the conventional diseases, but noting the wide distribution of filariasis, yaws, leprosy, dysentery, tuberculosis and skin diseases, the more limited areas of infection with malaria, leptospirosis and endemic typhus, and the recent epidemic course, in relation to the Zone, of epidemic influenza, measles and poliomyelitis.

All the diseases of major importance in the Zone were discussed, but particular attention was given to leprosy, malaria, filariasis, yaws and tuberculosis. These discussions emphasized a noteworthy feature of the conference: the appreciation of the correlated aspects of diagnosis and treatment, public education, economic standards, diet and the administrative arrangements of health and medical services. As an instance, the specific treatment of yaws was discussed, not only as a separate item, but as equally relevant, in reference to general administration, native medical education and international schemes of coordinated research. In other words, the conditions which exist in the Zone bring into clear perspective the interdependence of clinical, preventive and social medicine.

Amongst the papers reviewing disease conditions in the different areas, special interest was shown in reports on territories which, despite their contiguity, are little known—Dutch New Guinea and the island groups north of the equator under Japanese administration (the Mariana, Caroline and Marshall groups).

Leprosy.

The papers on leprosy had a unique value, since experiences reported included the special work of Dr. G. A. Ryrie at the Federal Leper Settlements at Sungei Buloh in Malaya, the largest leper hospital in the British Empire; the results obtained at Makogai, the central leper station for Fiji and the neighbouring island groups; the story of leprosy in the self-contained community on Nauru and the successful steps taken for its control; and other phases of leprosy control and treatment in Australia, Japan and China. Dr. Ryrie stressed to the conference the difficulty of assessing the value of any specific treatment in leprosy. He said that at Sungei Buloh the standard treatment was intradermal and intramuscular injection of hydnocarpus esters. Of the experimental intravenous injections of twenty-five different aniline dyes, fluorescein had been found the most useful. This was a compound of phthalic acid and resorcin. Extensive experiments with resorcin had proved useless. Recent experiments had shown, he stated, that cotarnine phthalate had a definite ameliorative effect on leprosy. This was still in the experimental stage, but it was hoped that a more lasting and less haphazard compound might be found, starting with the phthalate group as a basis.

Dr. A. H. B. Pearce (Fiji) reported the methods and results of treatment at Makogai, where in twenty-four years there had been a total of 1,761 admissions and 434 deaths, 32 discharges as non-lepers, 469 Indians repatriated, and 308 patients discharged as "arrested" (with 55 readmissions, half for reactivation and half for the treatment of trophic sores). Dr. Pearce said that recent results with iodized whole oil (chaulmoogra) had been good. Special importance was attached to general treatment as probably of greater value than specific treatment: hygienic and dietetic considerations, together with the treatment of intercurrent diseases, syphilis, yaws, hookworm, scabies *et cetera*. Dr. Pearce noted the racial variation of neural and cutaneous cases (Indians 36% and Fijians 52% of neural cases) and the higher rate of improvement among Indians. He suggested psychological and dietetic factors, which were also instanced by Dr. Ryrie in his Malayan experience—southern Indians suffering a benign mild nerve type of leprosy, the Chinese a far more virulent form, going on to gross ulceration, whilst the Malays had a leprosy intermediate in type. Dr. Ryrie stressed these racial differences in relation to treatment; what resulted in a wonderful cure in India might have very disappointing results in a Chinese population. None the less, in Dr. Ryrie's opinion, despite the manifold and difficult problems of leprosy, the only solution was the evolving of a successful treatment.

Dr. C. E. Cook (Northern Territory) described the interesting epidemiological fact of leprosy as it occurred in Australia: that leprosy in its active infective form predominated only in the coastal zone. In a survey some years ago, up to 80% of cases recorded from the coastal belt had been of the active nodular type, whereas in inland districts cases were few in number, and in these cases as many as 90% were of the less infective and more static anæsthetic type. Another somewhat similar feature was the experience at Channel Island Leprosarium, Darwin, that even without special drug treatment, the condition of patients improved during the dry south-east monsoon season and underwent retrogression during the humid north-west monsoon.

Dr. J. H. L. Cumpston reported to the conference the interesting story of leprosy in Nauru, the rapid spread of infection from 1920 to 1924, and its gradual decline under measures of treatment and control. In 1924 there had been 193 patients in segregation and 153 patients attending the out-patient leper clinic. At the end of 1934 there were 67 patients in segregation and 170 attending the out-patient clinic. Briefly, the system which had been devised after consultation with Sir Leonard Rogers and visits to the island by Dr. F. G. Morgan, of the Commonwealth Serum Laboratories, and Dr. (now Professsor) H. R. Dew, provided for the regular examination of every native islander every eight weeks during inspections which covered each district in turn. Infective patients were segregated in a special area. Non-infective patients (those discharged from segregation, "bacteriologically negative cases", discovered from time to time, and suspects) were treated at the out-patient clinic, where they received their injections twice a week. Treatment followed general lines of intramuscular injections of the

hydnocarpus methyl esters and intradermal injections of the methyl esters with iodine 1% and benzocaine 0·5% added (the latter as a local anæsthetic). Following the practice at Culion, "P.I. Dye" treatment was now being tried, Bonney's blue being used according to Ryles's method.

Dr. Genzo Katoh reported recent advances in Japan and the work of the Association for the Prevention of Leprosy, established in 1931 with an endowment from the Empress Dowager.

Dr. Wu Lien Teh referred to the informative history of leprosy in China by Lee S. Huizenga.

Local aspects of leprosy in their own territories were dealt with by Dr. Watt (New Zealand), Dr. de Rook (Netherlands East Indies), Sir Raphael Cilento (Queensland), Dr. Brennan (New Guinea) and Dr. Strong (Papua).

Malaria.

It was stated that the feature of malaria in the Austral-Pacific Zone was that the distribution of infection practically corresponded with the borders of Melanesia—north of parallel 20° south and west of meridian 170° east. The anopheles, in its spread from an Indo-Malayan habitat, had not yet been able to cross the sea gap between the islands to the south and east. To New Caledonia, Fiji, Samoa and the other groups to the east malaria was therefore of interest from the viewpoint of the possibility of the introduction of anopheles and infecton. In the New Hebrides, in New Guinea, in Papua, in the Solomon Islands and across northern Australia malaria was definitely a major part of the disease picture.

In an excellent survey of malaria as it affected the Mandated Territory of New Guinea, Dr. E. T. Brennan described how that territory, in comparison with other malarious countries, was singularly fortunate in that it harboured only one anopheline vector—*Anopheles punctulatus* and its variant *moluccensis*. Its habits were known and in control measures it was only necessary to search for the larvæ in clear ground water with, preferably, a little sunshine or a little shade. The success attained in freeing Rabaul and other town areas from malaria was already well known, but Dr. Brennan detailed the measures adopted in town and country areas for the drainage or treatment with oil or Paris green of anopheline breeding areas discovered by periodical mosquito drives. In the more difficult problem outside town areas the most successful anti-malarial measure had been the introduction of the larva-eating fish, *Gambusia affinis*. Dr. Brennan referred to a report by Dr. Holland, of New Ireland, in 1932, which very precisely indicated the success of this measure in thirty-two coastal villages in which *Gambusia* were introduced into all known anopheline breeding places. Subsequent examination of the native population had shown that the spleen rate in these villages had fallen from 24·6 in August, 1930, to 16·8 in February, 1931, to 12·8 in October, 1931, and to 4·2 in July, 1932. Moreover, for the first time on record there was an excess of births over deaths in these villages. In thirty-five other villages, not so treated, the spleen rate had remained over the same months at 47·1, 23·9, 24·7 and 28·8.

The Rabaul experience of the relative frequency of occurrence of different types of malaria would indicate that amongst Europeans subtertians constitute 76·5% and benign 23·5% of infections. Amongst natives in the Territory figures varied within very wide limits according to locality. The relative frequency of the different types in hospital patients had been recorded as subtertian, 68%, benign 21%, quartan 4%, and mixed 7%. There was a definite variation in severity of infection in different localities, and it was an interesting fact that incidence of blackwater fever corresponded more or less with "bad" areas of severe infections. With regard to treatment, "Atebrin" had been found very useful, but in an attack of any severity or with gastric symptoms quinine was considered necessary during the first twenty-four hours. Investigations of the leucocyte count in malaria carried out by Dr. Backhouse at the Rabaul Laboratory had confirmed Mochovski's findings that even in relative counts it was rare to find a high large mononuclear percentage, that when absolute numbers were considered mononucleosis was a rare phenomenon in malaria, and that the fall in the polynuclear cell count was the constant and useful prognostic sign.

In Netherlands New Guinea malaria was the most important disease, spleen rates were high, and the parasite rate in children was very high. Dr. H. de Rook gave some especially interesting information and personal experiences of that territory. In a malaria investigation he had carried out at Tanah Merah (on the Digoel River in southern New Guinea) during 1928-1929, he had found spleen rates of 95% in children and young adults; subtertian, benign and quartan infections and blackwater fever were common. Eight species of anopheles were determined, including *Anopheles punctulatus* var. *sol* and *Anopheles bancrofti*, of which the former was considered the more dangerous. In northern New Guinea malaria and blackwater fever were prevalent, and the mosquito carriers were *Anopheles punctulatus* and *Anopheles punctulatus* var. *mol.* *Anopheles bancrofti* was not found. An observation made by Dr. de Rook which was of comparative interest to Australian New Guinea, was that in his experience the malaria limit lay beneath 1,100 metres altitude.

Dr. C. L. Park described the work of the Malaria Commission of the Health Organization of the League of Nations. Its present programme included investigations into: (*a*) biological properties of different strains of parasites; (*b*) efficacy of treatment by synthetic remedies; and (*c*) the possible relation between the geographical distribution of sub-species of *Anopheles maculipennis* and malaria. He explained the action being taken to carry out controlled experiments of the therapeutic properties of a standard mixture of the total alkaloids of cinchona which the Malaria Commission had recommended for use. He also referred to the successful courses in malariology which were being held under the auspices of the Eastern Bureau at Singapore and which had been attended by Dr. F. W. Clements, Dr. H. C. Hosking, and Dr. C. E. Cook, of the Commonwealth, New Guinea and Northern Territory services.

Yaws.

Dr. W. M. Strong opened a discussion on yaws, quoting from his experience, which dated back to 1904. In Papua bismuth salicylate suspended in olive oil (1 in 8) was in general use, the ordinary dose for the young adult being two cubic centimetres (practically four grains of the bismuth compound). He favoured this compound, not so much on the ground of its cheapness, but because it was less dangerous in the hands of partially trained individuals, and in their experience gave a clinical cure in 90% of cases, compared with 92% with "914".

Dr. P. J. Monaghan described the successful work of the Yaws Campaign in Samoa, which had been assisted by the Rockefeller Foundation. Three injections of "Novarsenobenzol" were given in treatment.

Dr. H. de Rook reported that in Netherlands New Guinea yaws was very prevalent, and "Neosalvarsan" injections were widely given intravenously, except in small children, when intramuscular injections were made.

Dr. C. L. Park referred to the possibility of concerted research into the relationship of yaws and syphilis.

Filariasis.

An interesting discussion on filariasis was opened by Dr. G. A. M. Heydon, of the School of Public Health and Tropical Medicine, Sydney. He summarized what was known of the distribution of *Wuchereria bancrofti* and of *Filaria malayi* and of the mosquito transmission of these two worms. He said that in Melanesia and New Guinea the microfilariæ exhibited the usual nocturnal periodicity in the peripheral blood, unlike the condition in Polynesia. Dr. Backhouse, at Rabaul, had definitely shown for the first time that *Anopheles punctulatus* was hospitable to *Wuchereria bancrofti* (as suggested by Buxton). Later work in Rabaul had indicated that *Finlaya kochi* seemed

to be very hospitable experimentally, more so than *Anopheles punctulatus*.

Dr. H. de Rook described the widespread prevalence of filariasis in Netherlands New Guinea, where only *Microfilariæ bancrofti* had been found. (In the Netherlands East Indies both *bancrofti* and *malayi* existed.) As regards mosquito carriers, only negative findings had been reported.

Dr. A. H. B. Pearce reported the importation of *Megarhinus splendens* into Fiji for the destruction of the larvæ of *Aedes variegatus* as an anti-filariasis measure.

Dr. H. de Rook suggested the use of *Lutzia* as even more active, according to work reported from Amsterdam.

Tuberculosis.

Introducing the subject of tuberculosis in native races, Dr. W. M. Strong recalled that thirty years ago it was generally said that the natives of the Pacific were bound to die out as a result of tuberculosis. Whilst tuberculosis still remained a problem, evidence was now available to indicate that these native races were capable of withstanding the invasion of tuberculosis. Particularly interesting contributions to the discussion were made, reporting surveys in such different communities as the Hanuabada village adjoining Port Moresby, the inland highlands of New Guinea, Solomon Island villages, and the Maori population of over 2,000 in one New Zealand county. At Hanuabada, in 1,841 Mantoux tests, 39% gave negative results, 35% positive (+), 20% positive (++), and 5% positive (+++). There was a slightly higher percentage of positives amongst the males, no doubt owing to closer contact with the white population. This survey had been carried out in cooperation with the Territory service by Dr. F. W. Clements, of the Sydney School of Public Health and Tropical Medicine, this year. Last year, Dr. G. A. M. Heydon had carried out 105 von Pirquet tests in the Upper Ramu district, inland in New Guinea, and all gave negative results. This year he had carried out about 570 von Pirquet tests on native adults in the Mount Hagen district, and only 1·4% of weak reactions were obtained. More than ten years before, Dr. Heydon had obtained a rate of over 40% in indentured natives in Rabaul, and more recently Dr. Backhouse had obtained even higher rates.

Dr. H. B. Hetherington reported results obtained by Dr. S. M. Lambert in the Solomon Islands, where, of 1,553 natives tested, 86·88% of the adults and 57·1% of children between six and sixteen years of age gave positive results.

In the Maori population it was reported by Dr. M. H. Watt that practically the whole of the adult population reacted to the Mantoux test, except in one village, which was almost completely isolated from Europeans, and very little positive reaction was found.

Leptospirosis and Endemic Typhus.

The situation regarding leptospirosis and endemic typhus in Queensland was fully reported to the conference by Dr. W. C. Sawers, by Dr. T. J. P. Cotter, Townsville, and by Sir Raphael Cilento. A detailed demonstration in the laboratory and museum was also explained to delegates from overseas.

Diet in Relation to Health and Disease.

The importance of diet in relation to health and disease in the Pacific groups is a subject to which attention has repeatedly been drawn, and which, as a result, is now being recognized by administrations and employers of labour. At the first International Pacific Health Conference in 1926, Dr. (now Sir) R. W. Cilento and Dr. Strong urged the preeminent importance of the subject, and in their special experience both again discussed the many-sided problems of dietetic deficiencies at this conference. In an informative address Professor Harvey Sutton traversed the whole field of diet in relation to climate, race, work, health and survival. He illustrated phases of the question with Australian experience with regard to diet generally and the dietetic deficiency and related diseases of rickets, goitre, trachoma, Barcoo rot, and certain mental conditions.

Dr. Wu Lien Teh presented a paper on diet in China, which provided a very interesting comparative study of a diet adequate in energy value, probably adequate in vitamins *B* and *C*, suboptimal in protein and vitamins *A* and *D*, and deficient in calcium.

Dr. F. W. Clements reported the results of his investigations in the laboratory and in the field in New Guinea and Papua, which indicated an association between "tropical ulcer" and the dietary of natives, high in carbohydrates, low in proteins, and deficient in vitamins (especially *A* and B_2).

Administration and Native Medical Education.

The programme of the conference was so arranged that the concluding day should be devoted to an exchange of reports and experience on administrative questions under the many and diverse conditions which exist in the countries and territories represented at the conference. It was considered that this interchange would bring out not only differences and contrasts, but similarities and comparisons of problems which are being faced by every health and medical service. As a result, the papers presented to the conference will form a very valuable record for subsequent detailed study by all who are interested in public health and medical administration. Dr. Wu Lien Teh presented informative papers on the National Quarantine Service in China and on public health progress in that country. Special interest was taken in a report by Dr. Genzo Katoh on health and medical administration in Taiwan (Formosa) and in the South Sea islands under Japanese administration. Equally excellent records of colonial administration were given in a paper by Dr. de Rook on public health educational work in the Netherlands East Indies, in a description by Dr. Watt of the services in the Dependencies of New Zealand and in the Mandated Territory of Samoa, in a report by Dr. Strong of the work in Papua, and in Dr. Brennan's account of Australian administration in the Mandated Territory of New Guinea.

As a definite part of that general administrative policy every administration has attempted some form of native medical education, the training of the native to give medical service to his own people in his own territory. Delegates gave to the conference a fascinating story of what has been attempted and achieved in this field.

It was pointed out that the credit for the inauguration of the native medical practitioner system in Fiji was due to Dr. B. C. Corney, Chief Medical Officer for Fiji, in the early eighties. It was not perhaps generally known that the school at Suva anticipated by many years the Kitchener Memorial Medical School for Soudanese youths at Khartoum. That school was accepted as a model of its kind and stood as a memorial to the wisdom of two great administrators, Viscount Milner and Lord Kitchener, who saw the part which medicine should play in the civilization of the natve races. The Native Medical School at Suva had been attached to the old Colonial Hospital until the Colonial War Memorial Hospital was opened in 1923. In 1928 the present Central Medical School had been opened with assistance from the Rockefeller Foundation and a full-time tutor was later appointed. The school now had a faculty of fourteen honorary lecturers, and teaching was carried out in English. The school served all the adjacent groups as well as Fiji, with forty students drawn from Fiji, Tonga, Gilbert and Ellice Islands, New Hebrides, Eastern Samoa and the New Zealand groups (Western Samoa, Cook Islands and Niue). After the four years' course these native medical practitioners returned to their own groups and periodically attended post-graduate courses of six months' duration. A beginning had also been made with the training of native nurses with a three years' course at the hospital in Suva, and it was hoped further to develop this scheme.

In New Guinea and Papua conditions differed markedly from those which existed in Fiji and its neighbouring groups. Each territory had therefore developed its own native medical education schemes according to these local conditions. In New Guinea the system of native medical supervisors or medical *tul-tuls* dated back to the period

of German occupation, but had been largely developed since by the Australian administration. Districts and sub-districts were all cut up into patrol subdivisions. Each village in fully or partially controlled areas had its medical *tul-tul* or orderly, who had been selected and given a minimum of three months' training in the native hospital of his district. In some large districts where transport was scarce, small subsidiary native hospitals, in charge of a trained hospital orderly, were established, and in other districts paid travelling *tul-tuls* were appointed to visit all villages in the area and to see that each local *tul-tul* was doing his work.

In Papua the system of local and travelling native medical assistants developed by Dr. Strong had now so advanced that selected groups were being brought to the School of Public Health and Tropical Medicine at Sydney for a special six months' course. On return of the first group to Papua in March, 1934, they had been distributed all over the Territory and had given every satisfaction. At the time of the conference a group of these Papuan students were commencing their course, and native medical assistant Lahui Ako was selected to read a paper to the conference describing the work of his service in Papua.

In regard to the Netherlands East Indies and Netherlands New Guinea, it was explained that an interesting system existed of Malay doctors trained at the medical schools in Batavia and Soerabaya, and of male and females *mantris* (assistants). The native doctors had first to attend an elementary school to learn the Dutch language. They then received an intermediate education for five years (physics, mathematics and a foreign language) and then underwent six years' medical training and passed a final examination. These native graduates were entitled to practise on the same basis as those who had graduated in Holland. The *mantris* had to possess a diploma from one of the native primary schools and were then employed in a large hospital for three years, after which they passed an examination and entered the government service. These *mantris* played the basic part in the health education of the villages by house-to-house visits to insure direct contact with the people.

To provide for the scattered small islands in the Marshall group, the Japanese Government had in operation a system of training district native physicians, recruited from natives who had graduated from public schools with excellent records. A three to five years' medical training was given at government hospitals. Those who completed the course were authorized to practise in certain districts under the restriction of not using narcotic or dangerous drugs or surgical instruments.

Results of the Conference.

No formal resolutions or recommendations were adopted by the conference. There was, however, general agreement amongst delegates that it would seem very desirable that the conferences should be held regularly, possibly at centres in the Austral-Pacific Zone in rotation. Various matters of administrative detail in connexion with the epidemiological intelligence system (especially regarding urgent telegraphic advice of epidemic prevalences of diseases such as influenza) and quarantine cooperation and practice were deferred for subsequent correspondence between administrations concerned. The possibilities of correlated and concerted investigations along certain well defined lines were placed before the conference by Dr. C. L. Park. He indicated several inquiries already in hand on an international basis in which the Eastern Bureau at Singapore served as the centre for Eastern countries—nutrition, malaria, the relationship of syphilis and yaws, tuberculosis, amongst others.

An outstanding feature of the conference was the frank interchange of opinion and information between delegates, not only in connexion with medical and scientific subjects, but in details of administration and policy. It was generally agreed that the official and personal liaisons established at this conference would further materially the cause of cooperative effort between health services in the Austral-Pacific Zone and in the near-by countries of Asia.

Correspondence.

PATENT MEDICINES.

Sir: We are being flooded with literature concerning new drugs, with outlandish coined names, put up in tablet form, and which are coming more and more into use by medical men. If one can credit advertisements, there is little that cannot be cured by tablets carrying names of the same type as "Memnogan" and such like (this, of course, is a fictitious name given to illustrate meaning). But it must be made known that these tablets are being sold by chemists as patent medicines. Recently a patient asked me what was the name of the medicine that a chemist here was selling for blood pressure. I interviewed the chemist and he explained that he did not prescribe but only sold patent medicines, and produced a packet of the tablets in question with a new coined name—one of the class of which we get frequent advertisements.

If these drugs in tablet form and otherwise are to be sold by chemists as patent medicines, a new and very reprehensible situation arises. It would be interesting to hear what the British Medical Association and also the presidents of the various pharmaceutical associations think on the point.

Yours, etc.,
"F.R.C.S."

October 10, 1935.

Proceedings of the Australian Medical Boards.

QUEENSLAND.

The undermentioned have been registered, pursuant to the provisions of *The Medical Acts, 1925 to 1933*, as duly qualified medical practitioners:

Devenish-Meares, Molly Constance, M.B., 1931 (Univ. Sydney), Emerald.

Fitzgerald, Leo Joseph, M.B., B.S., 1933 (Univ. Melbourne), Nanango.

Rosen, Eric Nathan, M.B., B.S., 1931 (Univ. Sydney), Bundaberg.

Corrigenda.

Dr. Kenneth Wilson (Brisbane) writes that he has been misreported in the issue of October 5, 1935, at page 459. He is reported, in the discussion on the toxæmias of pregnancy, as having stated that "he could always prevent a patient from developing these conditions". What he said was that he had not been able to convince himself that he had ever been successful in preventing a patient from developing the condition.

Dr. H. R. Sear (Sydney) writes that in the issue of October 5, 1935, at page 466, in reply to his discussion, the words "elderly people" have been used in place of "adults". The sentence should read: "Most cases that he had seen in the ribs were in adults."

Books Received.

THE THEORY AND PRACTICE OF ANÆSTHESIA, by M. D. Nosworthy, M.A., M.D., B.Ch., with a foreword by I. W. Magill, M.B., B.Ch.; 1935. London: Hutchinson and Company. Crown 8vo., pp. 223. Price: 12s. 6d. net.

MEDICINE FOR NURSES, by W. G. Sears, M.D., M.R.C.P.; 1935. London: Edward Arnold and Company. Crown 8vo., pp. 419, with illustrations. Price: 8s. 6d. net.

INJURY AND INCAPACITY, WITH SPECIAL REFERENCE TO INDUSTRIAL INSURANCE, by H. E. Griffiths, M.S., F.R.C.S.; 1935. London: Baillière, Tindall and Cox. Royal 8vo., pp. 278. Price: 12s. 6d. net.

DISORDERS OF THE BLOOD: DIAGNOSIS, PATHOLOGY, TREATMENT AND TECHNIQUE, by L. E. H. Whitby, M.A., M.D., F.R.C.P., D.P.H., and C. J. C. Britton, M.D.; 1935. London: J. and A. Churchill. Royal 8vo., pp. 551, with illustrations. Price: 21s. net.

THE BOOK OF THE IT: PSYCHOANALYTIC LETTERS TO A FRIEND, by G. Groddeck, M.D.; 1935. London: The C. W. Daniel Company. Crown 8vo., pp. 301. Price: 10s. 6d. net.

METHODS OF TREATMENT, by L. Clendening, M.D.; Fifth Edition; 1935. St. Louis: The C. V. Mosby Company; Melbourne: W. Ramsay. Royal 8vo., pp. 879, with illustrations. Price: 60s. net.

PHYSICAL DIAGNOSIS, by W. P. Elmer, B.S., M.D., and W. D. Rose, M.D.; Seventh Edition; 1935. St. Louis: The C. V. Mosby Company; Melbourne: W. Ramsay. Royal 8vo., pp. 919, with illustrations. Price: 50s. net.

DISEASES OF THE SKIN, by R. L. Sutton, M.D., Sc.D., LL.D., F.R.S., and R. L. Sutton, junior, A.M., M.D., L.R.C.P.; Ninth Edition, revised and enlarged; 1935. St. Louis: The C. V. Mosby Company; Melbourne: W. Ramsay. Royal 8vo., pp. 1433, with 1,310 illustrations and 11 coloured plates. Price: 75s. net.

Diary for the Month.

Oct. 22.—New South Wales Branch, B.M.A.: Medical Politics Committee.
Oct. 23.—Victorian Branch, B.M.A.: Council.
Oct. 24.—New South Wales Branch, B.M.A.: Clinical Meeting.
Oct. 25.—Queensland Branch, B.M.A.: Council.
Oct. 31.—South Australian Branch, B.M.A.: Branch.
Oct. 31.—New South Wales Branch, B.M.A.: Branch.
Nov. 1.—Queensland Branch, B.M.A.: Branch.
Nov. 4.—New South Wales Branch, B.M.A.: Organization and Science Committee.
Nov. 5.—Tasmanian Branch, B.M.A.: Council.
Nov. 6.—Western Australian Branch, B.M.A.: Council.
Nov. 7.—South Australian Branch, B.M.A.: Council.
Nov. 8.—Queensland Branch, B.M.A.: Council.
Nov. 12.—Tasmanian Branch, B.M.A.: Branch.
Nov. 12.—New South Wales Branch, B.M.A.: Executive and Finance Committee.
Nov. 13.—Victorian Branch, B.M.A.: Branch.
Nov. 19.—Tasmanian Branch, B.M.A.: Council.
Nov. 19.—New South Wales Branch, B.M.A.: Ethics Committee.

Medical Appointments Vacant, etc.

For announcements of medical appointments vacant, assistants, *locum tenentes* sought, etc., see "Advertiser", pages xvi, xvii, xix.

Alfred Hospital, Melbourne, Victoria: Resident Pathologist.
Balmain and District Hospital, Sydney, New South Wales: Junior Resident Medical Officer.
Launceston Public Hospital, Launceston, Tasmania: Resident Medical Officer.
Perth Hospital, Perth, Western Australia: Resident Pathologist and Biochemist.
Public Service of South Australia: Inspector-General of Hospitals.
Royal North Shore Hospital of Sydney, New South Wales: Honorary Anæsthetist.
Western Suburbs Hospital, Sydney, New South Wales: Honorary Consulting Urologist.

Medical Appointments: Important Notice.

Medical practitioners are requested not to apply for any appointment referred to in the following table without having first communicated with the Honorary Secretary of the Branch named in the first column, or with the Medical Secretary of the British Medical Association, Tavistock Square, London, W.C.1.

BRANCH.	APPOINTMENTS.
New South Wales: Honorary Secretary, 135, Macquarie Street, Sydney.	Australian Natives' Association. Ashfield and District United Friendly Societies' Dispensary. Balmain United Friendly Societies' Dispensary. Friendly Society Lodges at Casino. Leichhardt and Petersham United Friendly Societies' Dispensary. Manchester Unity Medical and Dispensing Institute, Oxford Street, Sydney. North Sydney Friendly Societies' Dispensary Limited. People's Prudential Assurance Company Limited. Phœnix Mutual Provident Society.
Victorian: Honorary Secretary, Medical Society Hall, East Melbourne.	All Institutes or Medical Dispensaries. Australian Prudential Association, Proprietary, Limited. Mutual National Provident Club. National Provident Association. Hospital or other appointments outside Victoria.
Queensland: Honorary Secretary, B.M.A. Building, Adelaide Street, Brisbane.	Brisbane Associate Friendly Societies' Medical Institute. Chillagoe Hospital. Members accepting LODGE appointment and those desiring to accept appointments to any COUNTRY HOSPITAL are advised, in their own interests, to submit a copy of their Agreement to the Council before signing.
South Australian: Secretary, 207, North Terrace, Adelaide.	All Lodge appointments in South Australia. All Contract Practice Appointments in South Australia.
Western Australian: Honorary Secretary, 205, Saint George's Terrace, Perth.	All Contract Practice Appointments in Western Australia.
New Zealand (Wellington Division): Honorary Secretary, Wellington.	Friendly Society Lodges, Wellington, New Zealand.

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